GAS JOURNAL

LIGHT ⁘ HEAT ⁘ POWER ⁘ BYE-PRODUCTS

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Editorial Notes.

Company Meetings and the Gas Investor.

FEBRUARY was a busy month for the "JOURNAL," with the reporting of gas company meetings, before the British Industries Fair came to be an important annual event, making large additional demands upon both space and staff. These demands have been met hitherto; and there is no reason to doubt that they will be met in the future. To make the financial year coincide with the calendar year is a course which must possess many advantages for the gas undertakings themselves; and the only disadvantage that we have been able to discover is the personal one already mentioned. So we go forward cheerfully to the chronicling of the good results achieved in 1928 by one of the most beneficent industries of our time. The "ball is opened" in to-day's number by the speech of the Chairman of the Aldershot Gas, Water, and District Lighting Company. Mr. Edwards, as usual, has a good tale to unfold, and, equally as usual, he has been notably prompt in unfolding it. By the way, speaking of tales (or should it be tails?), we recently observed with some amount of pleasure that in one direction at any rate Mr. Edwards's undertaking is proposing curtailment. In a Bill which is being promoted by the Aldershot Gas, Water, and District Lighting Company in the present session of Parliament, it is asked that the name should be changed to the shorter title of the Southern Power Company. Perhaps some other companies will kindly note!

If during the next month or so a large proportion of the space at disposal in the "JOURNAL" should be devoted to reports of proceedings at gas companies' meetings, it will be recognized that this is by no means the least valuable feature of our pages. There are many thousands of gas investors up and down the country; and by the aid of the large number of very full reports—in many cases, indeed, practically verbatim—of companies' meetings which are published in the "JOURNAL," they are able to follow the fortunes, not only of those in which they may be financially interested, but of other undertakings as well. This must be worth something, both to the companies and to investors and potential investors. Under changed economic conditions, the class of people with money—even if only small sums—to invest seems to be growing continually; and any publication which, like the "JOURNAL," may be the means of turning their minds into safe channels, is rendering a public service. There are so many rough and rock-strewn straits in which, unpiloted, the frail craft of the small capitalist may easily come to grief. In the calm sea of the gas industry, he can sleep sound o' night—a blessing which only those who have been storm-tossed can fully appreciate.

Truly, the gas industry—though "gentle zephyrs" blow—is, as has just been remarked, a calm sea; and proprietors can await the annual meetings with a full measure of confidence as to the outcome. Time was, of course—and that not so very long ago—when these gatherings took place at half-yearly intervals; but it was eventually felt that, in so steady-going an industry, a yearly repetition of the announcement "Onward, ever onward," would be sufficient. Broadly speaking, this may be so; but twelve months is a long interval, and it might well be that a brief statement by the Board, sent out with the interim dividends, would be welcomed by many proprietors. A suggestion of a somewhat similar character has recently been put forward by Mr. W. J. Stevens, in the columns of the "Financial Times," but in relation to the British Railway Companies, to shareholders in which information at shorter intervals might be more useful than in the case of gas proprietors. What Mr. Stevens has to say, in reference to the Railway Companies, is this: "It is a distinct misfortune, under present circumstances, that we have no official information in regard to anything except gross railway traffic from one year's end to another, particularly so in these precarious times. A small exception to this general statement may be admitted in connection with the last series of interim dividends; but the reasonable demand that has been made for some time past for monthly working statements has not yet been met. With the more complete information which will be available in the course of the next two months, I believe it will come to be realized that the depreciation has been greatly overdone." If this should actually prove to be the case, it will be evident that more timely announcements might have been the means of obviating serious losses. Would it be too much to suggest that much of the popularity of the mining market is due to the short intervals at which results of working and progress reports are issued?

Thermal Insulation.

OF recent years much attention has been devoted to heat conservation in the many processes which collectively constitute what is known as gas-making plant. The waste-heat boiler has met with almost universal adoption, retort settings of all types are protected as far as is practically beneficial from loss of heat by radiation, and any unlagged boiler plant and steam pipe would be hard to find. It is therefore surprising that such little consideration has been given to thermal insulation of gas-consuming appliances—particularly water heating equipment. However, in this respect there is now a strong movement in the right direction; and the staff of Watson House have investigated the problem closely from the combined point of view of theory and practice.

In this issue of the "JOURNAL" is published the first part of a paper embodying the findings of experimental work on the lagging of domestic hot water supply installations. It was contributed by Mr. C. A. Masterman,

B.A., A.I.C., who is a member of the technical staff at Watson House, to the proceedings at a meeting of the London and Southern District Junior Gas Association on Friday last; and the author has done good service to the industry as a whole, for his original observations and mathematical expressions will excite interest and call for close study far beyond the confines of the Association itself.

It is not our intention to review Mr. Masterman's paper. Here we wish merely to draw attention to the gravity of the question with which he dealt, and to the manner in which the application of a heat-conserving jacket may extend the utility of gas-burning apparatus. In the first place, it has to be remembered that no gas boiler is a perfect means of transferring to the water the heat of the gas consumed. Even with the high efficiencies which characterize modern domestic gas boilers, every heat unit lost from the water represents nearly one-and-a-half units produced by the burning gas. Hence, by preventing the loss—whether by conduction, radiation, or convection—of 1 B.Th.U., the consumer's bill is reduced to the extent of 1½ B.Th.U. The extent of the actual money saving which can be effected by the application of suitable insulation is shown by an analysis of the results of Mr. Masterman's experimental work. Even a simple degree of lagging may result in a saving of gas amounting to anything between 10 p.ct. and 50 p.ct. on normal household usage—a fact which will eliminate the one disadvantage of gas for continuous water heating. Particular interest attaches to the author's simple mathematical expression for forecasting the gas saving to be anticipated from lagging a hot water set under any reasonable conditions of usage.

The merits of various types of lagging and of different finishes are dealt with in some detail by Mr. Masterman, who suggests that a convenient and suitable form of lagging for application to existing installations is half-inch treated hair-felt attached inside a canvas duck jacket arranged for lacing into position. The æsthetic effect of this jacket is naturally not too good; but we rather think that those who regard a gas boiler as an *objet d'art* must have a utilitarian, not an artistic, vision. There is no need to position a gas boiler next to the Hermes of Praxiteles. In any case there is little to offend in the ultimate appearance of this lagging when it is finished with aluminium paint—a covering which in itself largely reduces radiation losses.

There is another aspect of lagging; and that is when insulation is effected during the manufacture of the appliance. Here, of course, the appearance factor does not come into account, for the lagging is incorporated in the design. Efficient insulation during manufacture has resulted in the marketing of a gas boiler fitted with luminous burners consuming a maximum of 10 c.ft. of gas an hour, and thereby rendering flue pipe equipment unnecessary. Installation charges of such a set are low; thermostatic action is abrupt, and thus efficient; and provided the domestic routine is arranged to accommodate the fact that when a heavy demand has been made on such a set it will be some hours before such a demand can again be met, there is the obvious convenience of constant availability of hot water at little expense. This is but one example of the way in which insulation can increase the potentialities of gas hot water service in the homes of every class of consumer, rich and poor alike.

For the Committee Rooms.

NOT by any means of an ordinary, unattractive character is the list of Private Bills touching upon the gas industry which has been prepared for consideration during the present session of Parliament. Though probably no big fights are to be expected, there are a number of more or less out-of-the-way features. To some of these attention was drawn in the editorial notes of the "JOURNAL" a fortnight ago; and inasmuch as with this issue we conclude our review of the Bills, reference may now be made to one or two further points worthy of note.

Among the measures whose main provisions were outlined last week was yet another amalgamation scheme—this time submitted by the South Suburban Gas Company, who are wishful to absorb the Northfleet and Greenhithe Gas Company, Ltd., under the terms of an agreement recently come to. It is stipulated that the price of gas within the Northfleet limits is to exceed by not more than 3d. per therm the price for the time being charged by the South Suburban Company in the remainder of the limits of supply, other than the urban districts of Bexley, Crayford, and Erith. This amalgamation scheme, of course, affords but one more illustration of present-day tendencies. There have, it is true, always been amalgamations of gas undertakings; but in the earlier days they represented usually the joining-up of competing concerns. The object now is not to put an end to competition, but to increase working efficiencies, cheapen the price of gas, and improve the service to the consumer, to the benefit of all concerned.

Another method of change of ownership—and one with which the industry has been familiar for the greater part of its life—is illustrated by the Bill of the Windermere Urban District Council, who are coming to Parliament in accordance with the terms of an Act of last year which provided that, if they introduced in this session a Bill to empower them to purchase the undertaking of the Windermere District Gas and Water Company, the Company should not oppose it, except upon matters of detail. Here, again, the terms of the agreement are set out. Another case of transfer—but this time of a far less common nature—is provided by the Yorktown (Camberley) and District Gas and Electricity Company, whose proposal is to purchase under an agreement which is scheduled the gas undertaking of the Wokingham Corporation. Seldom indeed does a local authority part with so highly valued a property as a gas undertaking; but in this instance the circumstances are peculiar. By an Order made in 1927, the boundary of the borough was extended, but no powers were conferred upon the Corporation to supply gas within the added area, whose requirements in this respect are met by the Yorktown Company. As a matter of fact, the area within which the Corporation are at present supplying gas is surrounded by that within which the Company are supplying. The Company are desirous of continuing the works of the Corporation; and there is a provision that the price to be charged by the Company to ordinary consumers within the borough shall be 1d. per therm less than in the parish of Wokingham Without.

A capital conversion scheme is brought forward by the Wandsworth, Wimbledon, and Epsom District Gas Company, who seek to convert their six classes of ordinary stock into one consolidated stock, to convert three classes of debenture stock into one class, and to be relieved from the sliding-scale provisions of an earlier Act—substituting for it provisions upon the principle of the basic price and basic dividend already authorized in the cases of several other London Gas Companies. The basic rate of dividend asked for is 5 p.ct., and the basic price 11·4d. per therm. In a report prepared by the Parliamentary Committee of the London County Council, it is pointed out that there are several differences between the proposals of the Wandsworth Company and those of the other Metropolitan Companies referred to. The basic price of 11·4d. compares with 11d.; while the division of the surplus profits in the proportions of four-fifths as the consumers' share, and one-tenth each for the holders of consolidated stock and the co-partner employees, compares with three-fourths and one-eighth in the other instances. Further, the Wandsworth Company make no provision for the promotion by a fixed date of a Bill giving an opportunity for revision of the basic price.

Other points noted include one in the Bill of the Winchester Water and Gas Company, who include a clause which relates to agreements between the Company and other gas undertakers, and another to empower the Board to appoint a Director of any company who may have entered into an agreement with them to be a Director of the Winchester Company. The last matter to which we will refer here is a clause in the Southport Corporation Bill, to ensure that no geyser or other similar hot-water apparatus heated by gas shall be used unless it is provided with a proper ventilating pipe or shaft open to the air.

Gas Legislation.

Readers will find a gratifying announcement in our "Parliamentary Intelligence" to-day, where it is reported that Mr. H. G. Williams (Parliamentary Secretary to the Board of Trade), in answer to a question on Monday as to whether the Government intended to introduce a Bill this session to amend the legislation governing gas undertakings, stated that they hoped to introduce a Bill very shortly. Our Special Correspondents add that from reliable sources it is understood that the Bill, which will be on modest lines and non-controversial, will be introduced in the House of Lords this week or next.

Gas Companies Operating Abroad.

It must be a long time since there was so much interest as is being displayed at the present moment in the stocks and shares of English gas undertakings operating abroad. Strong faith in the capacity of the Board once more to reap financial reward for sowing in so rich a soil as Buenos Ayres, has led to a steady and sustained rise in the shares of the Primitiva Company, whose fortunes were so sadly shattered during the war period. A few weeks ago there was witnessed a sensational rise in the stock of the Continental Union Gas Company—another undertaking which had fallen upon evil times as a result of the European upheaval. This rise was consequent upon negotiations over which the Board have been engaged. Also subject to war influences has been the Imperial Continental Gas Association, whose stock has for decades past been much favoured by investors; and here again there has been witnessed a very big rise in stock values. Yet another instance of much enhanced values is the European Gas Company, who, like those already mentioned, were detrimentally affected by the war, and have suffered grievously from the fall in the French exchange. About a fortnight ago, the Board (doubtless in view of the rise which was taking place in the value of the shares) issued a statement to the effect that they had no knowledge of any negotiations for absorption or of other special developments; but they now state that since issuing the former announcement, an inquiry has been received as to their willingness to entertain an offer for the purchase of the Company's interests in France. In these circumstances, and pending a decision by the Board, shareholders, it is added, will no doubt await a further communication before disposing of their holdings.

Gas Light Dividend.

Coming to the industry on this side of the channel, readers will note with pleasure the announcement of the dividend of the Gas Light and Coke Company which appears on another page of this issue. This shows an increase both in the amount distributed and in the carry-forward. Proprietors will look forward with confidence to the address of Sir David Milne-Watson at the annual meeting of the Company next week. The total dividend for the year is £5 11s. p.ct., which compares with £5 os. 8d. for 1927.

Street Lighting Tests at Doncaster.

Considerable attention has no doubt been directed, by a paragraph which appeared on p. 232 of last week's "JOURNAL," to experiments by Mr. Robert Watson, the Borough Gas Engineer and General Manager at Doncaster, on a number of lamps with the use of "Holophane" prismatic refracting glass. We shall shortly, through the kindness of Mr. Watson, be in a position to furnish our readers with full particulars of what is being done. In the meantime, we would take this opportunity of assuring them that Mr. Watson has not pointed out, as was unfortunately said in the "JOURNAL" paragraph already referred to, "that ordinary glass directs many of the light rays from the burner upwards, creating waste."

"Glycerin" Gas Drying Plant at Colwyn Bay.

To-day there is to be an official inspection of the reconstructed gas-works of the Colwyn Bay Gas Department where an installation of Glover-West verticals, of a daily capacity of 1,220,000 c.ft. of gas a day, has been erected. A feature of considerable interest in connection with the purifying plant is a unit for the drying of the gas produced, which has been installed by Messrs. Kirkham, Hulett, & Chandler, Ltd.; the process employed being the "Glycerin." We believe this to be the first plant of the type put to work on a commercial scale. A few details of the plant are included in a general description of the reconstructed works which is published in later columns of this issue of the "JOURNAL."

Gas Mains on Cushions?

Having read of suggestions favouring a scheme for rubber roads to lessen vibration, a correspondent writes to the "Financial Times" putting forward the idea that, if rubber paving is not yet quite practical, a system of laying gas mains on a cushion of rubber may do much to lessen vibration and "prevent those continual 'earthquakes' in the streets of London due to the bursting of gas and water mains."

"Gas Salesman" Supplement.

Like the first issue of the present year, which contained an inspiring address by Mr. F. W. Goodenough, and a special page of photos of Circle Chairmen, the "GAS SALESMAN" included with this number of the "JOURNAL" is of exceptional interest. Miss Gladys Burlton favours us with an address that will be studied with the care which the utterances of a business specialist like her are always certain of receiving. There are also reports of meetings of nearly all the Circles, which contain much of value to the gas salesman.

PERSONAL.

Mr. ARTHUR TENNANT, Assistant Sales Superintendent to the Croydon Gas Company, has been appointed Sales Manager to the East Surrey Gas Company (an amalgamation of the Redhill and Dorking undertakings), in succession to Mr. F. Wilkinson, who, on medical advice, asked to be relieved of the responsibilities of the position.

Alderman JOSEPH TAYLOR, Director of Messrs. Joseph Taylor (Saturators), Ltd., in addition to being Chairman of the Lighting Committee of the Bolton Corporation, is a member of the Gas Committee. In a recent issue of the local paper there is an appreciative comment on his valuable work for the municipality.

Mr. H. J. DONKIN, who has been looking after the interests of the Bryan-Donkin Company in the London and Southern area, is ceasing to take active control from the beginning of this year, but will continue, as his health permits, to visit his old friends in the gas industry. He has been ably assisted for the past ten years by Mr. B. Tomlinson, who, as announced in this "JOURNAL," died unexpectedly on Dec. 10 last. In consequence, Mr. C. W. CRAWSHAW has been appointed to take control of the London and Southern District, assisted by Mr. B. I. STONE. Mr. Crawshaw has successfully been in charge of the Company's Northern area for more than thirty years.

Mr. SYDNEY H. PACKER, Sales Manager to the Bradford Corporation Gas Department, and President of the Yorkshire Junior Gas Association, was on January 22 re-elected Chairman of the Publicity Club of Bradford; and Mr. H. Wilde, also of the Bradford Gas Sales Department, Hon. Treasurer of the Yorkshire Junior Gas Association, and Hon. Secretary of the West Riding of Yorkshire Gas Salesmen's Circle, was re-elected Hon. General Secretary of the Publicity Club.

Mr. FREDERICK LUX, who is well known to many members of the Institution of Gas Engineers, the annual meetings of which he has frequently attended, has been appointed Life Manager of the newly-formed Company under the name of "Luxmasse." Mr. Lux is the inventor of the chemical balance which bears his name; also of the "Lux" purifying material which has been marketed for fifty years. His firm, Frederick Lux, Ltd., ceased to exist at the end of last year, and has transferred all its interests to the new Company, Luxmasse, at Ludwigshafen on the Rhine.

OBITUARY.

The death occurred on Jan. 26, at 62, Drewstead Road, Streatham, S.W. 16, very suddenly, of pneumonia, of Mr. LEONARD ASKEW, Civil Engineer, of 82, Victoria Street, S.W.

Mr. BERNARD TOMLINSON, who had been mainly responsible for the work of British Furnaces, Ltd., in the London area, died on Dec. 10, 1928, as the result of what appeared to be a minor operation. His death is a great loss, and is deeply regretted by the Company and by the very many business friends he had made. He was a man with a distinct personality, and one not easy to replace. His colleague, Mr. B. I. Stone, will now be responsible for his work under Mr. Chas. W. Crawshaw, who is now taking charge of the London office.

FORTHCOMING ENGAGEMENTS.

[Secretaries of Gas and Kindred Organizations are asked to assist in making this diary of events as complete and useful as possible by sending the earliest intimation of all meetings.]

Jan. 31.—MIDLAND JUNIOR GAS ASSOCIATION.—Meeting in the Council House, Birmingham. Paper by Mr. T. A. Harvey, O.B.E., of Birmingham, on "The New Installation of 'W-D' Continuous Vertical Retorts at the Saltley Gas-Works."

Feb. 2.—SCOTTISH JUNIOR GAS ASSOCIATION (EASTERN DISTRICT).—Meeting, and visit to Kirkcaldy Gas-Works. Paperettes by Mr. R. Air, of Crossgates, on "Automatic Street Lighting;" and by Mr. D. Warden, of Dundee, on "Maintenance."

Feb. 2.—MANCHESTER AND DISTRICT JUNIOR GAS ASSOCIATION.—Meeting at Warrington. Paper by Mr. A. H. Burton, A.M.I.Mech.E., on "Gas-Works Rolling Stock."

Feb. 2.—MIDLAND JUNIOR GAS ASSOCIATION.—Visit to the works of Messrs. Mobberley & Perry, Ltd., Stourbridge.

Feb. 4.—ROYAL SOCIETY OF ARTS.—Meeting in John Street, Adelphi, W.C. 2, at 8 p.m. Third Cantor Lecture by Dr. C. H. Lander on "The Treatment of Coal."

Feb. 5.—BRITISH COMMERCIAL GAS ASSOCIATION.—Annual meeting of the Yorkshire District, in Leeds.

Feb. 6.—BRITISH COMMERCIAL GAS ASSOCIATION.—Annual meeting of the Scottish District, in Glasgow.

Feb. 9.—SCOTTISH JUNIOR GAS ASSOCIATION (WESTERN DISTRICT).—Meeting in the Royal Technical College, Glasgow. Short Papers by Mr. A. Macfarlane, of Glasgow, "Notes on Iron Oxide;" and by Mr. J. Greig, also of Glasgow.

Feb. 12.—NATIONAL GAS COUNCIL.—Meeting of the Central Executive Board.

Feb. 12.—FEDERATION OF GAS EMPLOYERS.—Meeting of Central Committee.

Feb. 16.—WALES AND MONMOUTHSHIRE JUNIOR GAS ASSOCIATION.—Meeting at Cardiff. Paper by Mr. T. H. Madden.

Feb. 16.—YORKSHIRE JUNIOR GAS ASSOCIATION.—Meeting at Bradford. Paper by Mr. E. R. B. French, of Leeds, on "Water Heating Problems."

Feb. 19.—BRITISH COMMERCIAL GAS ASSOCIATION.—Meetings of the Executive Committee and the General Committee, in Birmingham.

Feb. 23.—SCOTTISH JUNIOR GAS ASSOCIATION (WESTERN DISTRICT).—Visit to Messrs. J. G. Stein & Co., Ltd., Bonnybridge.

Feb. 25.—BRITISH COMMERCIAL GAS ASSOCIATION.—Meeting of the Finance Committee, in London.

Feb. 27.—SOUTHERN ASSOCIATION OF GAS ENGINEERS AND MANAGERS (EASTERN DISTRICT).—Meeting.

Feb. 28.—MIDLAND JUNIOR GAS ASSOCIATION.—Visit to the British Industries Fair, Castle Bromwich.

Feb. 28.—SOCIETY OF BRITISH GAS INDUSTRIES.—Council meeting in the afternoon.

March 5.—BRITISH COMMERCIAL GAS ASSOCIATION.—Annual meeting of the Lancashire Section of the Manchester District, in Manchester.

INSTITUTION OF GAS ENGINEERS.

Feb. 12.—Gas Education Executive Committee, 4 p.m.

Feb. 13.—Executive Committee, 10.30 a.m.; Finance Committee, 11.30 a.m.; Benevolent Fund Committee, 12 noon; Berlin Visit Committee, 2 p.m.; Council Meeting, 2.30 p.m.

ON THE ELECTRICAL SIDE.

Prices and Profits.

A report upon the following questions has been issued by the London and Home Counties Joint Electricity Authority, who have had under review the London Electricity Acts of 1925: (*a*) The limitation placed upon the London Electricity Companies with regard to divisible or retainable profits; (*b*) the obligation imposed upon them to reduce the charges for electricity; and (*c*) the reserve funds which the Companies may keep, as prescribed by these Acts. After setting forth the effects of the various clauses and agreements, the report concludes: "The questions raised in the report are not free from difficulties in the interpretation of the Statutes. It is clearly the intention of the scheduled agreements to limit divisible and surplus profits in such a way as to encourage reduced prices to, and increased consumption by, all classes of electricity users, and to exhaust the revenue of a company by (*a*) meeting proper expenses of generation and distribution, (*b*) providing limited interest and dividend charges and reserve and contingency funds, and (*c*) reducing charges for electricity. It is reasonable to believe that the proper application of the Statutes will lead to these results." There may be good, substantial hope for consumers held out by this report; but the conclusions do not appear to point markedly to those reductions in price which they no doubt ardently desire.

Where Gas Scores.

There is no intention of wearying our readers by pointing out all the respects in which gas scores over competing systems; but mention may be made of just one, because of the matter that has brought it to mind. During the past week, the principal topic of conversation in the gas industry has been the report on gas legislation of the Sub-Committee of the National Fuel and Power Committee. The first-rate importance of the document is also realized by the electricians; and we are pleased to note the admission by one electrical contemporary that in some respects the existing Acts do place the gas industry at a disadvantage, though some doubt is expressed as to whether Government intervention is likely to be beneficial. On the lines of the report, it would seem that it could hardly fail to do so. The "Electrical Review" (the publication in question) concludes its reference to the subject in the following terms: "During 1928 there has been a general advance in the value of gas securities, showing that the position of our rivals has not suffered from the 'favouritism' (!) displayed by the Government towards electricity. As for the proposed net work of pipes, extending over long distances, the fact that gas can be economically stored, and thus the pipelines can be run at a high load factor, is in its favour. The lack of storage on a large scale is the fundamental handicap of electricity supply, which necessarily lives from hand to mouth; were that disability removed, what an immense impulse would be given to the electrical industry!"

Rateable Value as a Basis of Charge.

In view of the interest which is at the present time being taken in the suggestion that the gas industry should be given freedom to arrange its methods of charge to suit particular cases, it is useful to note the experience of the electrical industry in this connection. While some of their systems may be thought complicated, others appear to work very well indeed. Should the gas industry eventually adopt anything on the lines of the soundest electrical schemes, it will doubtless be accused of "copying;" but that cannot be helped, since the electricians seem to have tried nearly every method imaginable. In a paper submitted at the fourth Electrical Development Association conference, Mr. C. H. Rayner, who is Sales Manager and Mains Surveyor to the Manchester Corporation, remarked upon the difficulty of standardizing a method of charge for electricity to suit all districts and every class of consumer, inasmuch as conditions and nature of demand vary widely according to the type of area to be supplied. The two-part tariff may be fairly regarded as the most popular method for both industrial and domestic purposes, if consumers are to be encouraged to make the fullest possible use of electricity. This method, Mr. Rayner stated, has been adopted in Manchester, where the industrial user is charged on a basis of a fixed figure on kilowatt of maximum demand, *plus* a low running charge for current consumed. The casual user is, of course, charged at flat rates for occasional or seasonal demand. There is a special and attractive "all-in" tariff for the domestic consumer, which consists of a yearly charge of 20 p.ct. on the 1914 or equivalent rateable value of the house, *plus* ½d. per kilowatt-hour for current. Although it might be said that there is no definite connection between the use of electricity and the rateable value of a house, it is found to be a convenient and fairly equitable method of assessing the standing charge to be recovered from each consumer to meet fixed costs of supply. It is easily worked, and readily understandable by the consumer, and has proved exceedingly popular in Manchester, as is shown by its adoption by over 8500 consumers. On rare occasions only does one hear complaints of unfair incidence of the annual fixed charge on this basis. Consumers are by this system of charging encouraged to make full use of electricity for many purposes; and figures of 0·6d. to 0·75d. per kilowatt-hour are quite a common average price paid.

What Would Happen?

Colonel Wilfrid Ashley (the Minister of Transport) must be recognized by the electrical industry as a staunch advocate; and we hope there will be a proper feeling of gratitude in con-

nection with his latest proposal. Electricians are never tired of telling people how greatly the blessings of electricity are desired by the rural population; but having some doubts upon the subject ourselves, we are wondering whether this fresh suggestion would be likely to result satisfactorily to the purveyors of this particular form of energy. Colonel Ashley was speaking at the annual dinner of the Electrical Contractors' Association, when he said, according to the report of his speech which appeared in "The Times," that the electrical industry might safely be described as the most prosperous major industry in the country at the present time, and its progress showed signs of acceleration. An aspect of development which appealed to him particularly was that of rural electrification. It would be to the benefit of the country as a whole that the rural areas should not have to wait ten or twelve years to get the same benefits as the urban districts. Without divulging the name of the body he had personally approached, he might state that he had hopes that at no distant date it might be possible to select a rural area for development, and that that body would be able to say to every householder in that typical rural area: "If you so desire it, you shall have electricity brought into your house, and you shall not have to pay down a lump sum for wiring. We will do the wiring for an annual payment, and will provide you with anything you want, either on the hire or on the hire-purchase system." He desired to do this in order to test whether there was a great desire on the part of the rural population to get electricity.

The rural population will be wishful to know the terms upon which they may enjoy the blessings derivable from the "most prosperous major industry in the country." The welcome accorded to the first outward and visible sign of the coming of electricity has not been of universal warmth.

GAS STOCK AND SHARE MARKET.

[For Stock and Share List, see later pages.]

Speculative activity in Industrials continued to be the chief feature on the Stock Exchange last week. Investment securities also went ahead at first, but the gold withdrawals, and the uncertainty with regard to the monetary position in New York, slowed up the movement towards the end of the week.

There was considerable support in evidence in the Gas Market, even for this time of the year, when so many reports and accounts are due for publication. It will be seen from the List that, with the exception of a slight set-back in the Continental Union stocks and one *ex* div. fall, all the movements were again in an upward direction. The chief ones were rises of 4 points in Aldershot 5 p.ct. maximum, and 3 points in Lea Bridge ordinary and Wandsworth 5 p.ct. preference.

The first of the dividend announcements are satisfactory. The South Metropolitan Company, by a payment of 3¾ p.ct. (actual) for the half-year, maintain their dividend of 6¼ p.ct. for the year, and the Gas Light and Coke Company, by the payment of £2 16s. p.ct. (actual) for the half-year, average £5 11s. p.ct. for the year (which compares with £5 0s. 8d. p.ct. for 1927). At the time of writing, the accounts are not yet available, but the latter Company appear to have a surplus balance of over £37,000.

It will be seen that the Tottenham District "A" and "B" stocks are now shown in the List as ordinary stock. There is little doubt that the consolidation of the standard dividend stocks obviates a good deal of confusion in the minds of the gas investor, and is to be recommended.

The following transactions were recorded during the week:

On Monday, Bournemouth "B" 12⅝, British 117, Colombo 37s. 3d., Commercial 100¾, Continental Union 125, 127¼, 128, European 11$\frac{7}{16}$, 11½, 11⅝, Gas Light and Coke 19s., 19s. 0¾d., 19s. 2¼d., 19s. 3d., 19s. 4½d., 19s. 6d., 3½ p.ct. max. 64¾, 65½, 4 p.ct. pref. 79¼, 79¾, 80¼, 3 p.ct. deb. 59½, 60, Imperial Continental 271, 272, 272½, 273, 274, 275, 276, 277, 278, 279, Primitiva 26s. 9d., 27s., 27s. 1½d., 27s. 4½d., South Metropolitan 107¼, 108¾, 109, South Suburban 5 p.ct. deb. 99, 100, Tottenham "B" 102¾, 103½, Wandsworth "B" 115½. Supplementary prices, Gas Light and Coke 5 p.ct. deb. 101, Liverpool 5 p.ct. 91½, Romford "B" 94.

On Tuesday, Aldershot 4 p.ct. pref. 72, Alliance and Dublin 99, 100, 101, Bournemouth "B" 12¾, Commercial 100½, 3 p.ct. deb. 60½, Continental Union 123, 124½, 125, 7 p.ct. pref. 129, Croydon max. div. 86, European 11½, Gas Light and Coke 19s., 19s. 1½d., 19s. 3d., 19s. 3¾d., 19s. 4½d., 3½ p.ct. max. 65, 65½, 4 p.ct. pref. 80½, 3 p.ct. deb. 60¼, 5 p.ct. deb. 101, Imperial Continental 275, 276, 277, 277⅝, 278, 279⅜, 280, 280½, 281, 282, 283, 284, Lea Bridge 5 p.ct. 121, 121½, Liverpool 7 p.ct. pref. 102¼, Oriental 115½, Primitiva 26s. 6d., 27s. 3d., 4 p.ct. deb. (1911) 80, Sheffield "A" 103¾, South Metropolitan 107¾, 108, 108¼, 3 p.ct. deb. 60, 61. Supplementary prices, Gas Light and Coke 5 p.ct. deb. 101.

On Wednesday, British 116½, Continental Union 123, 125, 7 p.ct. pref. 126, European 11⅜, 11½, 11$\frac{9}{16}$, Gas Light and Coke 19s., 19s. 1½d., 19s. 2¼d., 19s. 3d., 19s. 4½d., 3½ p.ct. 65½, 4 p.ct. pref. 80, 3 p.ct. deb. 60½, Imperial Continental 278, 280, 281, 281½, 282, 283, 284, Lea Bridge 5 p.ct. 121, Liverpool 7 p.ct. pref. 102$\frac{13}{16}$, Primitiva 26s. 9d., 27s., 27s. 3d., South Metropolitan 108, 108¼, 109, 3½ p.ct. deb. 60, Tuscan 25s., Wandsworth 5 p.ct. pref. 93. Supplementary prices, Gas Light and Coke 5 p.ct. deb. 1952-57 101, Harrogate 5 p.ct. deb. 99, 99½.

On Thursday, Aldershot 4 p.ct. pref. 74¾, Bombay 21s. 6d., Continental Union 123, 125, 7 p.ct. pref. 126, European 11½, Gas Light and Coke 19s. 1½d., 19s. 3d., 19s. 4d., 3½ p.ct. max. 65¼, 4 p.ct. pref. 81, 5 p.ct. deb. 101, Imperial Continental 278, 279, 280, 280½, 281, 283, 283½, Lea Bridge 5 p.ct. 122, Newcastle 3½ p.ct. 17s. 9d., South Suburban 5 p.ct. 110¼, 5 p.ct. deb. 99, Wandsworth 5 p.ct. pref. 94. Supplementary prices, Gas Light and Coke 5 p.ct. deb. 101, Hornsey new 5 p.ct. pref. 87½, Liverpool 5 p.ct. 91½, South Suburban 7 p.ct. deb. 100, 100½.

On Friday, Alliance and Dublin 100¾, Brighton and Hove 5 p.ct. 103¼, Continental Union 123, 124, European 11$\frac{9}{16}$, Gas Light and Coke 19s. 2¼d., 19s. 3d., 19s. 3¾d., 19s. 4¼d., 19s. 5¼d., 19s. 6d., 19s. 9d., 3 p.ct. deb. 60¼, 5 p.ct. deb. 101, Imperial Continental 277, 278, 280, 281, Malta and Mediterranean 5$\frac{11}{16}$, North Middlesex 6 p.ct. 105, Primitiva 26s. 9d., 27s., 27s. 1½d., South Metropolitan 108, 108¼, 108$\frac{5}{16}$, South Suburban 5 p.ct. 109. Supplementary prices, Bournemouth 7 p.ct. deb. 103, Gas Light and Coke 5 p.ct. deb. 1952-57 101, Hemel Hempstead new "C" 107, 107½, Kingston-upon-Thames 104¾, 105¼, Liverpool 5 p.ct. 91¼.

After the rather stringent rates which prevailed during the week, the release of week-end funds brought about easier conditions in Lombard Street; and while 3¾ p.ct. was sometimes paid for fresh day-to-day advances, the rate ultimately fell to 3 p.ct., old loans being usually renewed at 3½ p.ct. As expected, Treasury Bills were allotted at a higher rate, the average being £4 6s. 6·73d. p.ct., or 1s. 4·67d. p.ct. above the previous week's rate.

On the Foreign Exchange Market, the following were the closing prices: Sterling on New York, 4.84$\frac{15}{16}$; French francs, 124.05½; Italian lire, 92.65½; Belgas, 34.90; Spanish pesetas, 29.69; German reichmarks, 20.41; and Dutch florins, 12.09$\frac{9}{16}$.

In the Bullion Market bar gold remained at 84s. 11½d. per oz.; and silver, with India buying, rose slightly to 26⅛d. per oz.

The Bank Rate is 4½ p.ct., to which it was reduced from 5 p.ct. on April 21, 1927. The Banks' deposit rate is 2½ p.ct., and the deposit rates of the discount houses are 2½ p.ct. at call and 2¾ p.ct. at notice.

Low-Temperature Carbonization at Leeds.

A scheme for the establishment of a low-temperature carbonization undertaking on a fairly large scale at Leeds is the subject of negotiations now proceeding between Messrs. B. Whitaker & Sons (1928), Ltd., of New Brick Works, Elland Road, Leeds (an undertaking controlled by the British Cavity Brick and Tile Works, Ltd.), and the Leeds Corporation Gas Committee. The Managing Director of the negotiating Company is Major Braithwaite, an influential Leeds citizen; and Sir Charles Wilson, M.P., lately Alderman of the Leeds City Council, is a Director. The suggested site for the new low-temperature scheme is at the York Street Gas-Works of the Corporation, which it is proposed to purchase or lease. The works are the oldest and smallest gas-works in Leeds; and with the exception of a few emergency weeks in 1927, the plant has not been used since 1923, because the needs of the district are amply provided for by developments at other works. There is a coal storage capacity of 7000 tons. The installation, it is proposed, is to be on the same model as that of the South Metropolitan Gas Company. The primary object is to use the treated fuel instead of raw fuel in the brick works; and it may be found practicable to put the fuel and the bye-products on to the general market.

AUSTRALIAN GAS INSTITUTE.

The Australian Gas Institute held their Third Annual Convention in Melbourne on Nov. 20, 21, and 22 last, under the Presidency of Mr. R. G. PARSONS (Manager of the Footscray Works of the Colonial Gas Association, Ltd.).

Several interesting papers were read which provoked much helpful discussion; and notice of these will appear later in the "JOURNAL."

The following office-bearers were elected for the ensuing year:

President.—Mr. H. Tindale.
Immediate Past-President.—Mr. R. G. Parsons.
Senior Vice-President.—Mr. A. E. Bradshaw.
Junior Vice-President.—Mr. S. J. Janes.
Hon. Treasurer.—Mr. A. H. Smedley.

Council.

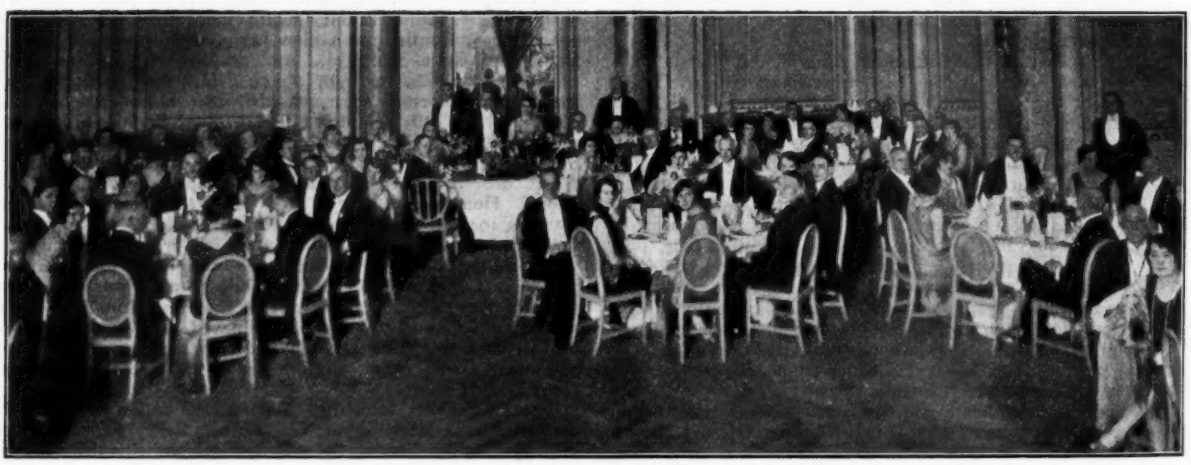
Northern Section.	*Southern Section.*
E. Foster	H. J. Bleauchae
E. J. Lord	J. Bowman
J. Mackenzie	C. F. Broadhead
E. C. Manfred	S. W. Durkin
T. F. Waugh	P. C. Holmes Hunt
A. Wilson	G. M. O'Dea

Auditors.

Northern Section.—Messrs. N. S. Kennedy and H. Wood.
Southern Section.—Messrs. J. W. Bennett and F. G. Barker.

The Retiring President, Mr. R. G. Parsons, was presented with a silver cigarette box suitably inscribed, while Mrs. Parsons was the recipient of a rose bowl.

EVENING STAR LODGE LADIES' FESTIVAL.



On Friday last, in the Edward VII. Rooms of the Hotel Victoria, Northumberland Avenue, the Evening Star Lodge, No. 1719, held the annual Ladies' Night, when members, their ladies, and their guests to the number of about 230 spent a delightful evening. The Worshipful Master, W.Bro. Arthur L. Croager, presided over the banquet and subsequent festivities; and Mrs. Croager was warmly welcomed by the brethren of the Lodge, whose regard for her was expressed in a beautiful bouquet of carnations and a more lasting gift in the form of a handsome crocodile hand-bag. The guests were representative of all branches of the gas industry and of other masonic lodges; and in the latter category special mention must be made of Bro. R. J. Meiklejohn, Master-Elect of the Murdoch Lodge, No. 3480.

The toast of "The King" was endowed with more than usual significance by the anxiety of past weeks only recently relieved by the more hopeful news of His Majesty; and the W.M.'s announcement that a telegram had been sent to H.M. the Queen evoked general satisfaction. The message was as follows:

"Her Majesty the Queen, Buckingham Palace.
We the members of the Evening Star Lodge and our ladies assembled at the Hotel Victoria, W.C., humbly beg to express our great gratification that His Majesty has made such good progress towards recovery and add the fervent prayer that he may speedily be restored to perfect health.

(Signed) Croager, Master."

Later in the evening the following gracious acknowledgment was received:

"Master, Evening Star Lodge, Hotel Victoria.
The Queen sincerely thanks the members of the Evening Star Lodge and their friends for their most kind message and good wishes.

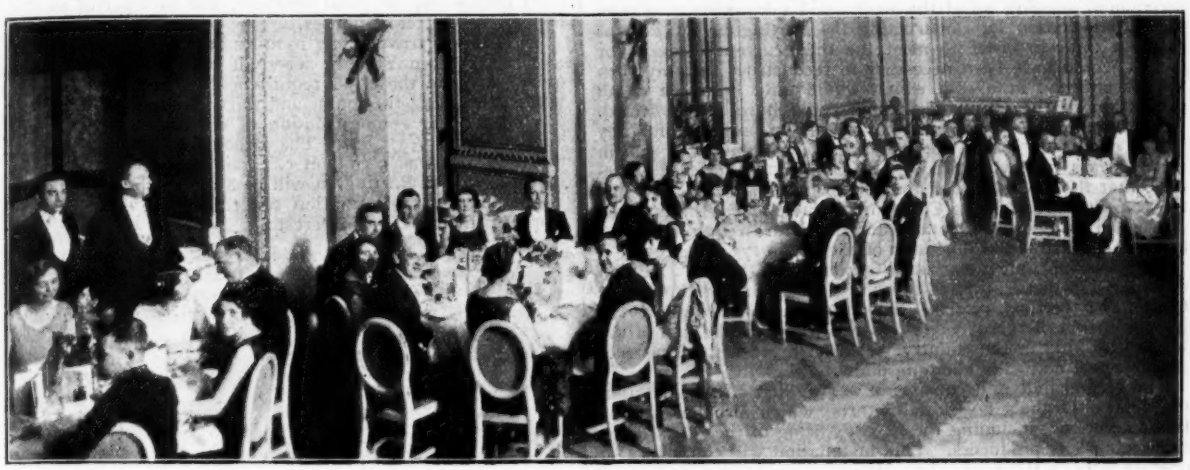
(Signed) Equerry."

The toast of "The Ladies" was proposed in felicitous terms by the W.M.; and the regard for them which W.Bro. Croager expressed so well was happily translated into tangible form by the presentation to each of a dainty "Everpoint" pencil. Mrs. Croager's reply on behalf of the ladies was a model of brevity and adequacy; the soul of wit being revealed in her forgiving the mere men for frequent absence, since the ladies were enjoying such a good time that evening.

W.Bro. A. H. Henry proposed the "Worshipful Master," and the toast was accorded musical honours. In his reply the

W.M. made special reference to the work of organizing the festival so ably carried out by W.Bro. Rae Normand, Bro. Foreman, and the Bros. Potterton; and he asked the company to rise while their health was toasted.

During dinner a charming programme of music was rendered by Harper's Imperial Orchestra; and afterwards there was an entertainment by leading artistes, accompanied by W.Bro. Herbert Townsend, an old friend of the Evening Star Lodge. The items were interspersed with dancing, which continued with éclat into the small hours, when the party broke up with regrets and universal appreciation of the skill and hard work which had made such an evening possible.



SOCIETY OF BRITISH GAS INDUSTRIES.

Council Meeting.

A Meeting of the Council was held at 56, Victoria Street, Westminster, S.W., on Thursday, Jan. 17—Mr. R. J. MILBOURNE, the Chairman, presiding. Those present were Messrs. C. A. Goodall (Vice-Chairman), A. B. Balmford, G. Clark, S. Cutler, G. Ewart, E. J. Fox, F. J. Gould, G. J. Jackson, A. H. Lymn, J. W. Scott, B. B. Waller, C. R. F. Threlfall, Col. E. A. Wilson, Dr. E. W. Smith (Hon. Treasurer), Mr. E. J. Davison (Hon. Secretary), and Mr. Arthur L. Griffith (Secretary).

The CHAIRMAN referred in feeling terms to the deaths of the following members of the Society:

Mr. H. S. Smith-Rewse, Vice-Chairman of the Whessoe Foundry and Engineering Company, Ltd.; Mr. J. T. Daly, Managing Director, the Horseley Bridge and Engineering Company, Ltd., and Mr. William Perrott, Chairman, C. & W. Walker, Ltd. At the request of the CHAIRMAN, the members stood in their places as a mark of respect.

Apologies for absence were reported from Messrs. F. Dobson, D. M. Gibb, and F. West. A donation of two guineas was voted, as previously, to the London Chamber of Commerce for their Commercial Education Fund.

Dr. SMITH presented the report of the British National Committee on the World Power Fuel Conference, and stated that, in consequence of the success of the Conference last year, 50 p.ct. of the amount guaranteed was being returned to the large guarantors.

JOINT GAS CONFERENCE IN BIRMINGHAM.

The CHAIRMAN reported matters in connection with the Joint Gas Conference to be held at the British Industries Fair at Birmingham in February, and stated that Lord Ednam had agreed to preside at the Conference on the first day.

It was decided to take a page advertisement for the Society in the "Times" Trade and Engineering Supplement to be issued during the Fair, and a Sub-Committee was appointed to draw up the advertisement. It was also decided, in conjunction with the National Gas Council and the British Commercial Gas Association, to approve the British Gas Industry's number of the "Empire Mail" to be issued at the end of March, as it was felt by the Council that it would be particularly opportune for a special number to be issued at that time, and that the members of the Society be recommended to give it their consideration and support.

The report of Dr. Smith on the Industrial Conference on Bituminous Coal held in Pittsburgh, U.S.A., at which he acted as Delegate for the Society, was submitted.

The following were nominated the Society's representatives on the Grand Council of the Federation of British Industries:

Main Group 2, Sub-Group 5—Elevator and conveyor manufacturers . . .	Mr. E. J. DAVISON.
Main Group 2, Sub-Group 12—Coke ovens, gas conveying and chemical plant manufacturers	Mr. SAMUEL CUTLER.
Main Group 2, Sub-Group 13—Heating and cooking apparatus manufacturers	Mr. CHARLES CLARE.
Main Group 15, Sub-Group 1—Gas appliances manufacturers: (*a*) Gas mantles, (*b*) gas fittings	Mr. F. C. TILLEY.

MIDLAND ASSOCIATION OF GAS ENGINEERS AND MANAGERS.

On Monday of last week, the Midland Association of Gas Engineers and Managers, whose greatly respected President is Mr. W. G. S. Cranmer, of Willenhall, had a dinner and dance at the Grand Hotel, Birmingham. In spite of the inclemency of fog and cold, there was a large and distinguished gathering of members, their ladies, and guests; as many as 150 being received in the ante-room by the President and Mrs. Cranmer, who was presented with a handsome bouquet by the officers and Committee of the Association.

The object of the function being purely social, the toast list had apparently been designed merely to aid the digestion of the company; and after the Loyal Toast, Mr. JAMES PATERSON was the first to prescribe to that laudable end by proposing the health of the President. As an Hon. Member Mr. Paterson was able to testify to the excellence of Mr. Cranmer as head of the Association. Perhaps, he remarked, the President's most remarkable characteristic was his modesty; indeed, it might be said that his light had been hidden under a bushel. The speaker laid special stress on the many years of work which Mr. Cranmer had done for the younger members of the industry, who looked up to him with gratitude and real affection.

The toast having been accorded musical honours, Mr. CRANMER expressed his warm appreciation, and paid a tribute to those members who had helped in the organization of the evening's entertainment—especially to Mr. T. Thornton, the Hon. Secretary, who had so successfully carried out what might be called the "donkey work." They were delighted to have with them the President of the Institution of Gas Engineers, from whom they would appreciate a few words.

Mr. JOHN TERRACE, who was cordially received, referred to the work of the Institution of Gas Engineers. It was, he said, fairly well co-ordinated with the help of the District Associations, but he thought it could be bettered—notably by the addition of the personal touch; and this it was his pleasure to attempt to add by visits to the District Associations. During the past year it had been his good fortune to be associated with those of younger blood who felt that the doors of the Institution should be widened in order to help forward the work which they all had in hand. He was pleased to say that their efforts had resulted in such progress that people were saying what good work the Institution were doing. As regards the Charter, he was not at present at liberty to speak; but he was able to call special attention to the new scheme for awarding the Institution's Medals in gold, silver, and bronze, to which reference was made at the last Council meeting [see "JOURNAL" for Dec. 19, p. 783.]

The remainder of the evening was devoted to dancing, interspersed with a programme of delightful music.

NEW GAS-WORKS AT PARTINGTON.

The Manchester Corporation Gas Committee have made a preliminary inspection of their new Gas-Works at Partington, where gas making commenced on Friday, Jan. 25. The formal ceremonial starting up of the works will take place at a later date. The reason for constructing the Partington Works was the fact that, in order to meet the then current demand for gas, it would have been necessary to reconstruct the Gaythorn Works entirely, at a cost which would have been out of all proportion to the economies which could have been effected. In addition, there would still have been no provision for any future expansion which the increasing consumption of gas in recent years has warranted. The Committee decided, therefore, that the most suitable place for a new works was outside the congested area of the City; and the site at Partington was chosen as being best adaptable for the future requirements of the Gas Department. The area of the site is 175 acres.

The first half unit of carbonizing plant consists of a 4 million c.ft. per day installation of Messrs. West's Gas Improvement Company's vertical retorts. This plant incorporates all the improvements of recent years' research, and will be one of the best of its kind in the country. It also includes the latest designs of coal and coke handling plant.

The second half unit consists of a 4 million c.ft. installation of Messrs. Drake's horizontal retorts, which also has all the latest additions, including the gaseous firing of the furnaces by six Trefois gas producers. This installation will commence to operate later in the year. In addition to waste heat boilers on the vertical retorts, steam is being raised by Stirling boilers fitted with coke breeze travelling grate and mechanical stokers. Four sets of four purifiers on the luteless system have been erected—two sets by Messrs. R. & J. Dempster and two by Messrs. Newton Chambers. A 5 million c.ft. capacity spirally guided holder has been erected by Messrs. R. & J. Dempster. The manufacture of sulphate of ammonia will be by the semi-direct process, and the plant for this purpose has been erected by Messrs. W. C. Holmes & Co., Ltd. Concrete coal storage, with elevated railway sidings, has been provided with a capacity of 35,000 tons of coal. The coal will be mechanically emptied from trucks into overhead breakers, and transported to storage hoppers in the retort houses.

The gas will travel along 10 miles in a 36-in. steel trunk main to the Gaythorn Station, where it will be distributed as required to meet the city's requirements. The total cost of the works, including the main, and thirty houses which have been erected for the accommodation of certain employees, will be approximately £975,000. The carbonizing capacity of the Gaythorn Works was 5 million c.ft. per day, and the capacity of the first unit at Partington will be 8 million c.ft. per day.

The following information concerning the Manchester Gas Department may be of interest:

Capital employed	£5,904,842
Outstanding debt	£2,330,924
Coal carbonized	489,992 tons
Gas made	7,556,300,000 c.ft.
Coke produced	313,206 tons
Tar produced	5,659,461 galls.
Sulphate of ammonia produced	4,924 tons
Consumers	209,230
Appliances in use—	
Cookers	147,686
Grillers	17,865
Fires	52,933
	218,484
Miles of mains	1,109
Area of supply	53 sq. miles

The sale of gas is not now very greatly influenced by fog, but the effect of temperature is very marked. For instance, during the past week the average temperature was 6° Fahr. lower when compared with the same week last year, and the gas consumption increased by 13,771,000 c.ft., or 7·69 p.ct.

GAS BILLS FOR 1929.

(*Concluded from p. 211.*)

WINCHESTER.

Consequent upon the demands for water and gas in parishes adjoining their limits of supply, the Winchester Water and Gas Company are promoting a Bill for the extension of their area, and for further capital powers to enable them to cope with this increase of business. They also desire authority to use for the manufacture of gas and residual products, and for the storage of gas, certain lands already acquired by them, which are described in a schedule.

Extension of Limits.

The gas limits are to include, in addition to the existing limits, the parishes of Littleton, Crawley, Sparsholt, and Lainston, in the rural district of Winchester, and the parish of Hurslay. If after the expiration of five years from the passing of this Act the Company have not laid down mains for the supply of gas in any parish or part of a parish in the added gas limits, the local authority, or any company or person, may apply for an Act or a Special Order for the purpose of providing such a supply, and for the repeal of the powers of the Company. The clause is included which relates to agreements between the Company and other gas undertakers, as well as that which provides for securities being taken as a consideration. The Directors may at any time appoint a Director of any Company who have entered into agreement with them under these sections to be a Director of the Winchester Company, and for such purpose the number of Directors may be increased by not more than two.

The financial part of the Bill provides that the Company may, from time to time, raise additional capital not exceeding in the whole £80,000, by ordinary or preference shares or stock. The Company shall not in any one year make out of their profits any larger dividend on the additional capital to be raised under the powers of this Act than £6 in respect of every £100 actually paid-up of such capital as shall be issued as ordinary capital, unless a larger dividend be at any time necessary to make up the deficiency of any previous dividend which shall have fallen short of this sum, or than £6 in respect of every £100 actually paid-up of such capital as may be issued as preference capital. An increase in the borrowing powers is also sought. There are clauses to enable the Company to prepare and put in force a profit-sharing scheme. The provisions of the Gas-Works Clauses Act, 1847, with respect to the breaking-up of streets, shall apply, with the necessary modifications, to the laying down and construction within the gas limits of telephone or telegraph posts, wires, &c.

[*Parliamentary Agents: Messrs. Martin & Co.*]

WINDERMERE.

Purchase of the Gas and Water Undertaking.

By an Act of last year, it was provided that if the Windermere Urban District Council should introduce in the next session of Parliament a Bill to empower them to purchase the undertaking of the Windermere District Gas and Water Company, the Company should not oppose the Bill, except in so far as they might deem necessary in order to secure the insertion of provisions to protect their interests in the matter. It was further provided that if the Council should obtain such an Act, they should, as from the quarter day following the expiration of four months after the passing of the Act, purchase the undertaking of the Company for the sum of £74,000, free from any then existing debenture, mortgage, or other debts or similar liabilities, but subject to any other obligations of the Company under their Acts. The Council will repay to the Company any capital expenditure incurred, with the consent of the Council, after April 24, 1928. Also any sums paid for the purchase of water-works land described in a schedule to the agreement. If the money is not paid on the appointed day, the Council are to pay to the Company interest thereon at the rate of 5 p.ct. per annum. The Council will pay compensation to any officer who shall not be retained by them in the same or similar office, and at the same remuneration.

The limits for the supply of gas by the Council, after the transfer, shall be the district and the parishes of Undermillbeck and Troutbeck, in the rural district of South Westmorland, with the exception of a portion indicated. The price to be charged by the Council for gas shall not at any time exceed 15d. per therm, subject to revision by the Board of Trade, by way of increase or decrease, on the application of the Council or twenty consumers. There is a clause compelling repairs in case of danger.

For the purchase of the undertaking, and for defraying costs and expenses consequent thereon, the period of repayment asked is fifty years from the date of borrowing, and for working capital for the undertaking ten years.

[*Parliamentary Agents: Messrs. Lees & Co.*]

YORKTOWN.

Company to Purchase a Municipally-Owned Undertaking

Under the Wokingham Gas Order, 1894, the Borough of Wokingham were authorized to operate the undertaking of the Wokingham Gas and Coke Company, when the same had been acquired by them. By the Wokingham Extension Order, 1927, the boundary of the borough was extended; but no powers were

conferred upon the Corporation to supply gas within the added area—which is supplied by the Yorktown (Camberley) and District Gas and Electricity Company. The area within which the Corporation are at present supplying gas is surrounded by that within which the Company are supplying; and in these circumstances the Corporation have agreed to sell their undertaking to the Company. To enable them to cope with increasing demands, the Company ask to be authorized to continue the works of the Corporation and to raise additional capital.

As from the date of transfer (the end of the quarter next following the date of the passing of the Act), the Wokingham undertaking will be vested in the Company upon the terms set forth in the Bill, freed of all mortgages, debts, and liabilities. The Company are to pay to the Corporation in cash, within three months from the date of the passing of the Act, the sum of £35,600, and within one month from the date of transfer a sum to be agreed as the value of stores, loose plant, &c.

The price to be charged by the Company for gas supplied to ordinary consumers within the borough shall be 1d. per therm less than that charged in the parish of Wokingham Without. The price within the borough is not to be taken into account in ascertaining the rate of dividend payable on the ordinary stock of the Company.

The Company may from time to time raise, by the issue of consolidated ordinary or preference stock, such amounts as shall be sufficient to produce, after taking into account premiums and discounts, the sum of £40,000, with borrowing powers up to one-half. Power is taken to subscribe towards capital of other companies; and the clause regarding agreements between the Company and other gas and electricity companies, to which reference has been made in connection with previous Bills, is inserted.

[*Parliamentary Agents: Messrs. Hargreaves & Crowthers.*]

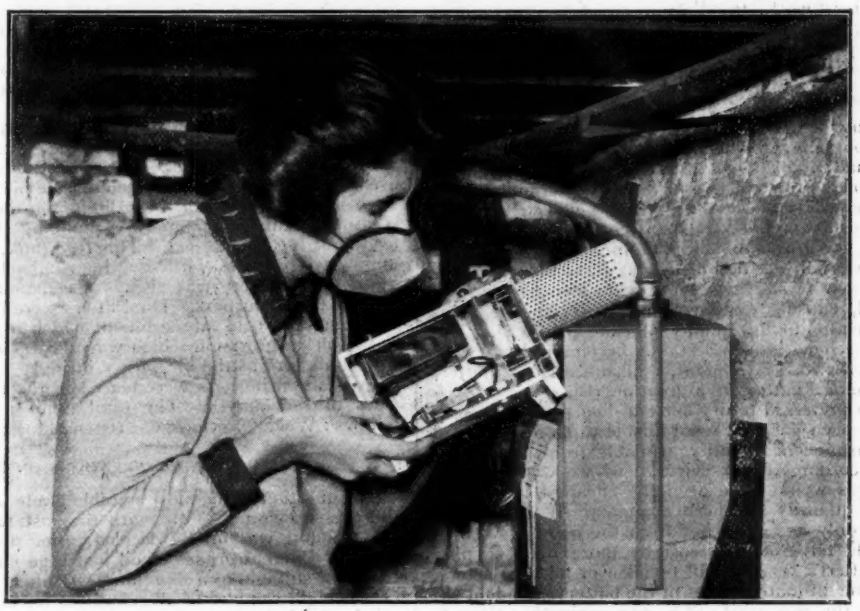
PROVISIONAL ORDER.

INVERNESS.

In a Provisional Order under the Private Legislation Procedure (Scotland) Act, 1899, the Town Council of Inverness seek, among other powers, authority to borrow a further sum of £50,000 for the purposes of their gas undertaking. The section provides that the Corporation may from time to time, with the consent of the Secretary of State, borrow on mortgage such sums as may be required.

[*Parliamentary Agents: Messrs. Beveridge & Co.*]

A LEAKAGE INDICATOR FROM FRANCE.



The accompanying photograph (by Walter Guiver, 184, Nelson Road, N. 8) shows an official testing the joints of a newly-fitted meter with a leakage indicator evolved by Mme. Espes, of Paris. The cover of the detector has been removed in order to give an idea of the mechanism. French experts state, we understand, that the instrument is infallible. The presence of 1·3 p.ct. of gas causes an electric lamp to glow and a bell to ring. We are informed that tests are now being carried out in this country, and that so far the device has passed them all satisfactorily—even the location of firedamp in mines.

COKE OVEN SCHEMES FOR SCOTLAND.

In the "Glasgow Herald" for Jan. 23 appeared an account of a lecture delivered on Jan. 22 by Mr. W. Hunter, of Edinburgh, to the members of Greenock Association of Engineers and Shipbuilders. His subject was "The Economic Value to the Nation of Coal and Its Bye-Products." Mr. James Brown, of Scott's Shipbuilding and Engineering Company, presided.

In the course of the address an interesting announcement was made as to a supply of gas in bulk to Glasgow and other towns. Mr. Hunter said there had been little development of the coke oven industry in Scotland, because for years it was given out that there was no true coking coal in that country, and developments for that reason had been relatively smaller than they had been in England. Improved methods of treating, washing, and mixing or separating coal had now, however, made it possible to produce coke in Scotland equal in quality to any of the standard English cokes.

In Germany, Mr. Hunter went on to say, the coke ovens were located alongside the blast furnaces, and vast quantities of surplus or low-grade gas discharged from the furnaces were used for heating the ovens, and thus the valuable gas was set free for sale in the towns. In that country gas was conveyed about 400 miles through pipe lines.

He was very glad to be able to tell them that such a scheme was now being promoted in central Scotland. It was proposed to lay down, about ten or twelve miles from Glasgow, a large battery of coke ovens right up against blast furnace plants. The blast furnace gas would be used to heat the ovens, or part of them, and the whole of the rich gas would be pumped through a large steel main to Glasgow and neighbouring gas consumers. There they would have an example of the perfect utilization of coal. The scheme was likely to take effect within the next two months.

A Future for Duff.

In the case of coke ovens, the coal which had to be used must be as fine as oatmeal before it was put into the ovens. That brought on a point that was of vital importance to the coal owner or the colliery undertaking. To-day 30 to 40 p.ct. of the total output of the Scottish coal mines was duff, which was less than $\frac{3}{16}$ in. in size. That coal cost as much to dig and bring to the surface as coal that was as big as a brick. The latter coal was sold at from 17s. to 25s. per ton, while duff was unsaleable at 4s. per ton. Any process that was going to make that duff, or fine coal, of the same or equivalent value to the higher-grade coal would be a tremendous asset to the coal trade generally. If they could make that duff relatively as valuable as the other coal, then they would have solved one of the coal trade's problems.

DRYING AND HEATING A COKE OVEN BATTERY BY LIQUID FUEL.

By W. H. RUSSELL and F. WHITE.

Paper before the Midland Section of the Coke Oven Managers' Association, Jan. 23.

In order to obtain a high efficiency in the working of an oven battery, it is essential that the structure shall be built upon a good, sound foundation; and during the building the greatest care should be taken in regard to the bonding of all joints in the brickwork, so as to ensure a maximum gas-tightness. In addition to these points, and perhaps most important, are the drying-out and heating-up of the ovens, which is the preliminary operation to bringing an oven battery into commission, and the care and attention which have to be shown in respect of the allowance to be made for expansion, both vertically and longitudinally, of the brickwork. The importance of this procedure will, we know, be familiar to you all, as it may mean the success or failure in the future working of a very valuable plant. It is with the object of explaining the method which was adopted at the South Yorkshire Chemical Works, Ltd., in bringing the oven battery into commission that this paper was written.

The method employed in bringing a battery up to a suitable temperature has generally been the provision of false grates, erected in each oven, upon which has been burned wood, coal, or coke. When it was assumed that the moisture had been driven from the brickwork, the heating-up of the ovens was carried on slowly, with, it is feared, but little control over the expansion which progressed immediately heat was introduced to the battery.

Results of Uneven Expansion.

It is common knowledge that various oven batteries have been ruined solely through unequal expansions during the heating period, and that had more control been exercised, together with careful checking of the rates of rise in temperature, and expansion, the batteries would have been far more efficient in after operation. The results of uneven expansion can, of course, be extremely serious, for it must be borne in mind that, in addition to decreased efficiency in the loss of bye-products through leakage, the whole system of regeneration (if a regenerative oven) is adversely affected, causing uneven temperatures in the walls which are detrimental to the quality of coke produced. The cost, too, of early repairs, which certainly become necessary, to oven walls and brickwork in general, is also a serious matter, and affects the life of a battery to a great degree.

We would have preferred to dry-out and heat-up the battery by means of coke oven gas, but were unable to do so owing to there being an insufficient quantity available from our waste-heat battery. According to our calculations we were assured that coke oven gas would have been the cheapest method to adopt if only the quantity had been available. It would have been cheaper not only as a fuel, but from the point of view of labour, and would have cut the cost by more than 60 p.ct. It was decided, after a very careful revision of all the factors, bearing in mind the ultimate success of the battery, to adopt the oil as opposed to the coal start. The two main objections to using coal were that structural alterations would have been necessary to the oven brickwork; and these we feared would later have caused serious trouble, as the coal fires are bound to cause unequal heating, and are not so capable of being regulated to within anything like the degree of accuracy which can be obtained by the use of oil or gas. The coal method may, in some cases, be cheaper than oil; but we were satisfied that the end in view justified the means, and our experience has confirmed our belief.

Building under Cover.

A point we would like to mention, in passing, is that we would advocate the entire building of an oven battery under cover, so that the brickwork is kept in as dry a state as possible, and also that building operations may not be stopped on account of climatic conditions. The result, we are convinced, means a great saving in whatever fuel is used for drying and heating up, and in addition there is less risk of uneven heating, with consequent uneven expansion. At Parkgate a corrugated iron structure was erected immediately the concrete raft, upon which the ovens are built, was laid, and before the delivery of silica bricks was commenced. The outcome was that the job went on smoothly under absolutely dry conditions on every part of the battery; and we are convinced that we were well repaid for making this provision.

Details of Plant.

Before explaining the process adopted for drying and heating the battery, we should like to give a few particulars of the ovens erected. The battery is of the Semet-Solvay double-pass regenerative type, having five horizontal flues. Between each oven is a solid silica division taper wall 18 in. to 20 in. thick. Thus each oven may, if necessary, be laid off without affecting its neighbour. The foundation for the battery is a reinforced concrete raft 2 ft. 3 in. in thickness, boat shaped in section, so that the waste-gas flues are contained within the raft. All the lower end tie-bolts of buckstays and bolts retaining the front ram rail are cast into the raft. All buckstays and tie-rods are exceptionally heavy and give adequate support to the brickwork. This type of oven lends itself readily to the provision of suitable separate expansion joints for each oven, without giving rise to the fear of gas leakage from one oven to another, and the putting of a thrust on the buttress. There are four longitudinal main flues built of semi-silica brick as far as the springing of the arch; and from this point the construction upwards is of silica brick. The facing course of the battery is of semi-silica, while on the oven tops, after the covering-in of the oven itself by 14 courses of silica brick, there is a further 3 ft. of ordinary red brick—this resulting in very cool oven tops. The regenerators are filled with chequerwork silica brick.

Operation of Ovens.

In the working of this type of oven there is no reversal of the gas which is burned in the flues, the air current only being reversed on a 15-minute schedule. The air inlet ports are situated at the chimney end of the battery immediately on the oven side of the main flue reversal dampers; the whole being housed in one room and operated by the one motor controlled through an electric clock. The operation of reversal occupies about 9 secs., and consists of the vertical rise or fall of the main flue dampers, and the horizontal movement of the air slide.

Our decision to adopt oil fuel being arrived at, plans were formulated for the arrangement of the general plant and fittings which would be necessary, and the specification of the oil to be used. It was decided that the creosote oil storage tanks which were in position should be utilized for the fuel, and also the creosote circulating pumps for pumping the oil to a common feed tank for the burners. This feed tank, which held approximately 150 galls., was fitted with a run back to the main storage tank, so that there was always a constant head of oil (30 ft.) feeding to the burners. Dual filters were fitted on the main oil feed range, to trap any sediment which may have been present in the oil—a provision which was most essential, on account of the small bore of the oil burner fittings.

In addition burners were placed in the regenerators on both sides of the battery. The total number of burners was as follows: Waste gas flues, 66; regenerators, 120; oven flues, 480.

Preliminary Observations on Fuel Oils.

The question of the most suitable grade of fuel oil to adopt on the ovens, commensurate with the cost, was thoroughly gone into; and it was finally decided, after preliminary laboratory tests on different grades of oil had been carried out, to subject the most suitable to a searching test under working conditions. Of the eight samples of oil submitted for testing, three were immediately decided upon as unsuitable, owing to the high viscosity. It would have been necessary to apply heat to such oils, in order to thin them sufficiently, so that they would reach the burner nozzle in a suitable condition for atomization; and this we decided was out of the question. Finally, our choice lay between two oils, and these were tried out under working conditions.

The following characteristics should, in our opinion, be insisted upon in order to obtain the maximum value from a fuel of this nature. (1) The oil should be capable of being easily atomized. (2) It should be of low viscosity at low temperature, to ensure ease of flow through the different pipelines, and finally through the narrow tube previous to being atomized. (3) Freedom from water and solid matter. (4) High calorific value. (5) Flash-point should be low. (6) Deliveries should be constant in quality.

The oil which was finally chosen to be used after preliminary burner trials on three different grades of oil had the following analysis:

Sp. Gravity at 60° Fahr.	0·864
Flash-point (close test)	168° Fahr.
Viscosity Red: No. 1 at 70° Fahr.	40 secs.
Spontaneous ignition point (approx.)	300°-350° C. in air
Calorific value per lb. (net)	19,500 B.Th.U.
Water	*Nil*
Free carbon	*Nil*

In addition to the favourable point of cost, this oil was of higher calorific value, giving greater flame intensity, was more readily ignited, and gave no deposition of carbon. Accordingly, to examine this fuel as to its behaviour under working conditions, a 24-hours' test was carried out; the burners (of which two types, English and American, were used) being fitted up under similar conditions to those obtaining on the ovens. The two types of burner differed only in the diameters of the com-

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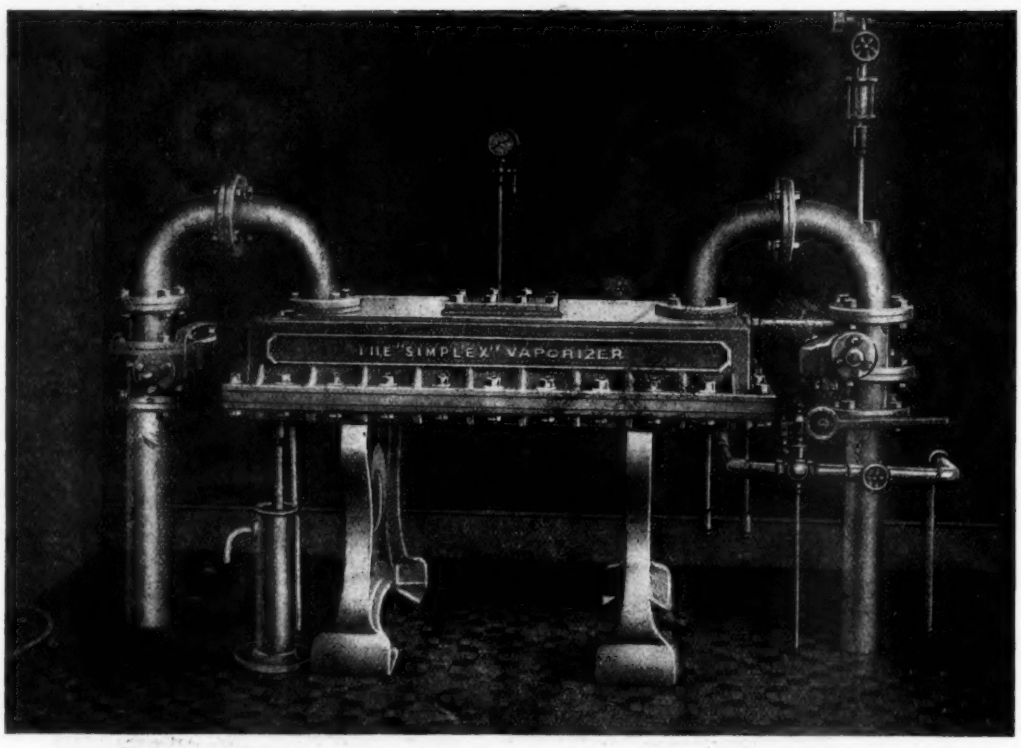

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bustion tubes; the diameter being rather less in the American burner. The oil was fed through a ½-in. diameter pipe from a drum of approximately 35 galls. capacity, at a head of roughly 14 ft. The necessary fittings for adjustments of oil flow and compressed air were embodied. A mercury **U**-gauge was also installed on the air line, at a point nearest the burner, so that the air pressure could be accurately measured at any time.

MAIN POINTS NOTED.

The main items it was desired to observe were: (1) Consumption of fuel at (*a*) minimum flame length; (*b*) maximum flame length. (2) Degree of atomization under conditions of (*a*) and (*b*). (3) Air pressure required for economic combustion. (4) Ease of ignition. (5) Adjustment to oil flow, also air volume. (6) General behaviour.

(1) *Consumption of Oil* could be varied from a minimum consumption of 0·105 gall. per hour per burner, giving a flame length of roughly 6 in., to a maximum consumption of 0·633 gall. per hour per burner, giving a flame length of approximately 24 in.

(2) *Atomization* was completed on the minimum flow, while on the maximum flow a small quantity of oil escaped in the form of a fine spray. By placing brickwork in front of the burner so that the tip of the flame impinged, this spray could be arrested, and burned on the face of the brick.

(3) *Air Pressure.*—It was found that an air pressure of 2 cm. of mercury (10·7 in. water gauge) was most suitable for a medium consumption of oil. If the air pressure was increased to 3-4 cm. pressure, the flame tended to leave the end of the burner. For complete atomization of the oil, approximately ½ cm. Hg. pressure appeared to be the minimum.

(4) *Ignition.*—This was obtained by turning on the air, then the oil, and by placing a torch lamp with a flame of about 4 in. behind the burner tube. The flame of the torch was drawn in through the secondary air supply holes, when ignition of the atomized oil immediately took place.

(5) *Adjustments.*—Provided the air pressure remained constant, very slight adjustment to either air or oil was required. During the preliminary trials an improvement in the steadiness of the flame was effected by bringing the end of the inner brass tube to within ¼ in. of the nozzle orifice. Previously this was set at rather more than ½ in. This alteration also appeared to lead to improved atomization.

(6) *General Behaviour.*—It was found that, if the oil supply was carefully regulated, very little deposition of carbon occurred in the combustion tube. If not, however, carbon was rapidly deposited, which stopped the free atomization of the oil; and the flame accordingly went out. If the burner tube happened to have a slight upward tilt, oil would accumulate, and burn under the supply nozzle, also resulting in a deposit of carbon, which would finally put the flame out. It was necessary to remove the carbon, immediately it began to form, by means of a pricker; otherwise an accumulation necessitated taking the burner down for cleaning.

It was thought necessary to minimize this deposition of carbon; and the men whose duty it was to attend to the burners during the drying and heating period received full instructions, and were shown how to manipulate the air and oil supply necessary to keep a complete atomization. With the added provision of a pricker for removing the carbon which might form, the after-experience proved this trouble to be almost negligible.

An important point to watch is that, in screwing up the lengths of pipeline, burner nozzles, &c., great care should be exercised in the use of red lead or other jointing material, as the smallest piece finding its way into the nozzle is sufficient to stop the flow of oil—which, of course, means the dismantling of that particular burner.

STARTING-UP THE PLANT.

Though in 1926 the position of erection of the plant was such that a start could have been made to dry out the ovens, the coal strike seriously delayed the procedure. Our old battery of ovens had to be restarted early in 1927, which further delayed operations on the new plant until February, 1927. Our first task was to bring the steam-raising plant into commission, so that the power sets, exhausters, pumps, air fan, &c., could be run in, and to assure ourselves that no serious hitch was likely to occur on this side, once operations were commenced. This task, after several minor delays which are common in all similar operations demanding plant of a like nature, was successfully accomplished; and on Feb. 16, 1927, the oil pumps were started for a preliminary circulation of the fuel oil from the storage tanks to the high-level feed tank, whence it was allowed to flow back to the storage tank. On Saturday, Feb. 19, 1927, the burners, numbering 66 (33 in each main flue), were lighted at 11.30 a.m.

Circulation of air was created throughout the flue by means of the fan; the chimney being blanked-off by a wooden bulkhead, and the chimney end of the inner flues also blanked-off in like manner, in order to direct the current of air down the outer flue, in which the operators were working. The fan was rated to deliver approximately 30,000 c.ft. of free air per minute against a head of 1 in. water pressure, and the air slide was placed centrally in order that each flue would receive the same amount of air. Air pressure supply on the manifold range to the burners was approximately 40 to 44 in. water gauge. Thermometers were fastened to wooden props, which reached to within a few inches of the top of the inner main flue arches. Temperature readings were taken, recorded, and reported every four hours. Oil stocks were taken every four hours, and consumption was recorded every eight hours, so that a close watch could be kept on the average consumption per 24 hours, and also per burner.

A SLIGHT HITCH.

The lighting of the 66 burners took approximately ten minutes, and they were adjusted to give a flame length of about 8 in. Matters progressed smoothly for 36 hours, when it became necessary to change-over exhausters, owing to a heated bearing. During this operation a seal was blown on the air main, resulting in a loss of air pressure to the burners, which were accordingly shut down until the seal was re-made. Very little discomfiture was caused in the main flues; the smoke produced by the oil burners through loss of primary air being quickly dissipated by the air current.

The average oil consumption per 24 hours from Feb. 19 to 23 was 260 galls., equivalent to 0·164 gall. per burner per hour. On Feb. 25 (6th day), owing to inclement weather, consumption of oil was increased to approximately 375 galls. per 24 hours, or 0·237 gall. per burner hour.

MEASUREMENT OF EXPANSION.

Vertical expansion readings were taken daily and recorded. The vertical expansion was indicated merely by the rise of the oven brickwork above the top of a steel rod resting directly on the concrete raft. This measurement was also checked by theodolite readings. The horizontal expansions were recorded by measuring the decrease in distance between the face of the ovens and a fine steel wire stretched taut between the extreme brackets fixed on the outer ends of the buttresses. It may be mentioned here that the whole 66 burners were behaving admirably, and required very little attention.

On Feb. 28 (10th day) temperatures in the main flues were rising in advance of the rate mapped out, and the oil burners were accordingly checked slightly. These conditions continued until March 2 (13th day), when the plugs at the sighthole for the damper at the bottom of the riser flue, which had been previously removed for the lowest air vent, were replaced in order to drive the heat upwards.

Horizontal expansion readings were commenced at this period (17th day). The degree in rise of temperature up to March 21 (32nd day) was satisfactorily maintained at the rate previously decided upon; and it became necessary at this point to conserve the heat at all possible points of the battery. Evidence of the effect of the rise in temperature was afforded by the increased amount of moisture escaping from the burner holes. All over doors were luted, and the space between all ascension pipe bottoms and the base was covered with brattice cloth. Valve seatings on the hydraulic main were filled with sand, so that no heat could escape.

DRY BRICKWORK.

On March 22 (33rd day), when temperatures in the main flues had reached 100° C., a remark was made by the American Engineer who was supervising the heating at this stage to the effect that he was surprised at the small amount of moisture driven out of the brickwork. It will be remembered that earlier in this paper stress was laid on the point of keeping all brickwork dry during stacking and building operations; and we are convinced that in our own case we derived great benefit by so doing.

On March 27 (38th day) oil consumption was increased to 200 galls. per eight hours, to maintain the rise in temperature. No trouble whatever had been experienced in regulating the burners, and very little carbon had deposited in the combustion tubes. On March 30 (41st day) the burners in the coke side regenerators were lighted, and preparations were made for the removal of the burners and pipelines in the main flues. At 11.30 a.m. the oil supply to these burners was shut off, and at noon all pipelines had been removed and the wooden bulkheads taken down. At 12.35 p.m. the air fan was stopped, and air reversal was started through the battery. Somewhat varied temperature recordings were obtained in one flue at this point; no doubt due to starting the air reversal. All regenerator burners were on by 12.45 p.m., and oil consumption was fixed at 500 galls. per eight hours. Gas burner holes were daubed up, and all plugs were replaced in sightholes. These conditions were maintained until April 6 (48th day), when the burners in one flue (ram side) were lighted, and the ram side regenerator burners were turned off. The following day the burners in another flue (coke side) were put on, and the coke side regenerator burners were turned off. The amount of expansion occurring up to this point necessitated the slacking off of the buckstaves, tie-rods, &c. The strutting in the oven chambers was also smouldering; and it was necessary to ease the leveller doors to let out the smoke and to burn the timber.

A decrease in temperature of the waste gases going to the

stack had taken place since reversal of the air current was made.

PROGRESS OF HEATING UP.

Several apparently high temperatures of oven chambers were obtained at this time (53rd day); these being affected by the burning of the bracings in the oven chambers. On April 15 (57th day) the burners in the ram side flues had to be turned up, in order to keep them burning; a strong wind on that side of the battery constantly blowing the flame out. On April 16 (58th day) the burners in the third flue ram side were lighted, and on April 20 (62nd day) the burners in the second flue coke side were started. The following day all ascension pipe base seals were filled with sand. Steam was also turned into the collecting main.

On April 25 (67th day) the oil consumption at the burners was increased to 1600 galls. per eight hours, and on the following day to 1800 galls. per eight hours. All the regenerator burners were put into operation on April 27 (69th day), in order to force temperatures up during the final few days. Oven chambers were now approaching a temperature suitable for charging coal, and at 4 a.m. on April 30 (72nd day) this was successfully carried out. All burners were kept on until 6.40 a.m., when the air and oil were turned off. By this time 15 ovens were charged, and gas was being put round the condensing plant. Dismantling of the oil burners was begun as soon as the oil range had been drained, and gas burners placed in position. At 11 a.m. gas was available in the main distributing range to the ovens, and no difficulty was experienced in burning the gas in the normal gas burner where installed, or in the oil burners which were kept in use temporarily until time permitted of their being changed.

SCHEDULE OF CHARGING.

The schedule of charging the ovens throughout the battery was as follows:

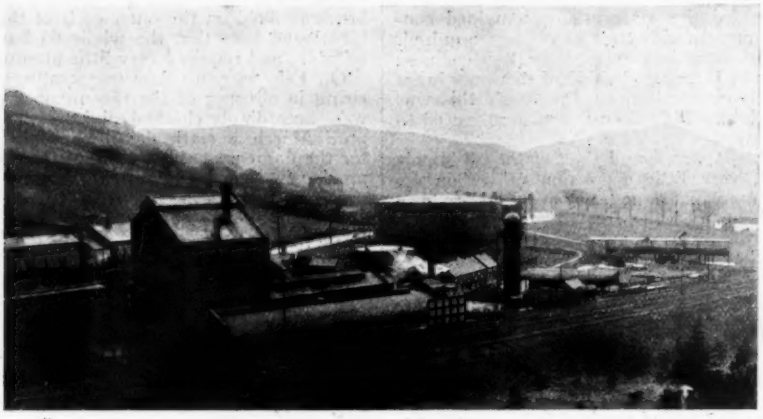
1st oven, No. 3 charged 4.36 a.m., Saturday, April 30, 1927.
10th oven charged in 1 hour 22 mins.
28th oven charged in 9 hours.
39th oven charged in 16¾ hours.
47th oven charged in 24¾ hours.
60th oven charged in 37½ hours.

All ovens were charged by 6 p.m. on Sunday, May 1. Coke was pushed at 7.15 a.m. on May 1, and continued on a 35 to 45 minutes schedule.

EXTENSIONS AT THE COLWYN BAY GAS-WORKS.

Installation of Glover-West Vertical Retorts.

To-day there is an Official Inspection of the Colwyn Bay Gas-Works, where a setting of Glover-West Vertical Retorts has recently been installed. The following is a description of the Works, including an Historical Note on the Undertaking of the Colwyn Bay Gas Department, and an outline of the "Glyceria" Gas Drying Plant erected by Messrs. Kirkham, Hulett, & Chandler, Ltd.



VIEW OF THE COLWYN BAY GAS-WORKS ON THE NORTH SIDE.

Gas was first supplied in the district by the Colwyn Bay and District Gas and Lighting Company, Ltd., formed in 1883. In 1884 the Company obtained the Colwyn Bay and District Gas Order, with a share capital of £8000 and a loan capital of £2000. The Company was incorporated by Special Act in 1896, with additional capital of £20,000; the loan capital being increased to £7000. The Act contained a clause enabling the Urban District Council to purchase the works within five years by agreement or arbitration. The total make of gas for the first year of working was 1,583,000 c.ft., and the price was 6s. per 1000 c.ft. There were 41 consumers and 42 public lamps.

The undertaking was transferred to the Urban Council in 1901, at the cost of £66,000. By this time the annual make of gas was 35,282,000 c.ft. The capital value of the works as purchased was equal to £1900 per million c.ft. of gas made. The capitalized value of the undertaking at March 31 last was £196,617, or about £936 per million c.ft., of which £172,924 was raised by loan, and the balance from the revenue account. Of the loan capital, £67,712 had been repaid, leaving a liability of £108,116 at March 31, 1928.

DEVELOPMENTS.

The following table shows the progress and growth of the undertaking:

Year.	Price of Gas per 1000 C.Ft.	Gas Made, in Thousands.	Number of Consumers.	Miles of Main.
	s. d.			
1885	6 0	1,583	41	..
1901	4 2	35,282	..	15¼
1911	3 4	76,085	2741	28
1921	4 2*	141,758	3358	35
1928	3 4	210,000	4884	45

* Price of gas raised from 2s. 11d. on account of coal strike.

The number of cookers in use is approximately 5000, in addition to which there are a large number of gas fires, wash boilers, hot water installations, and other appliances. The number of gas-lighted street lamps is over 700.

CARBONIZING PLANT.

Up to 1913 the whole of the carbonizing plant was operated by hand stoking, and consisted of 48 horizontal retorts 10 ft. long. At that date it was decided to instal machine charging and discharging plant. The retort settings were extended to 14 ft. long, and a Guest Gibbons charging and discharging machine was installed. In 1919, due to increase in the demand for gas, two units of Tully water gas plant were installed, each of 200,000 c.ft. per diem capacity.

The increased output being steadily maintained, the Engineer presented a detailed report on the complete re-equipment of the manufacturing plant. The lay-out of the site was to a large extent governed by the disposition of the existing plant. After careful consideration, it was decided to erect a unit of vertical retorts, at the easterly end of the existing horizontal retort house, of a capacity of 1½ million c.ft. per diem. Extension to this would be made in a westerly direction on the site of the existing horizontal retort house. This will allow for the development on that site to a capacity of between three and four million c.ft. per diem.

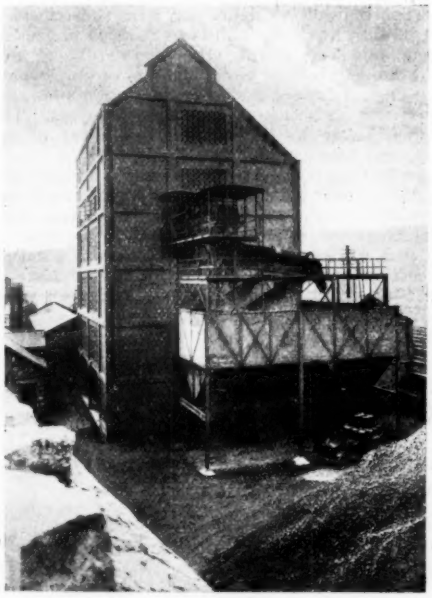
INSTALLATION OF GLOVER-WEST VERTICAL RETORTS.

The situation of the gas-works in proximity to the railway, and its nearness to the Queen of North Wales seaside resorts, made the adoption of the continuous vertical retort, with its freedom from the periodical smoke nuisance, a readily acceptable solution of a serious problem. The contract for the new carbonizing installation was placed with West's Gas Improve-

ment Company, Ltd., of Manchester, who have supplied sixteen of their Glover-West vertical retorts, of an estimated daily capacity of 1,220,000 c.ft. of gas. The retorts are elliptical in section, 25 ft. long, increasing uniformly from 40 in. by 10 in. at the top to 46 in. by 18 in. for 21 ft., and then more abruptly to the helical coke extractor chamber.

The retort house and coal store were arranged, in the original design of the gas-works, parallel to and alongside the main line of the L.M. & S. Railway; and the new carbonizing plant has been constructed in the same direction and prepared for easy extension. Railway wagons containing coal are emptied while on the railway siding, by means of hydraulic wagon tippers, into a hopper built into the railway embankment. The coal then passes through a breaker to a band conveyor, which feeds a conveyor of the lipped-gravity-bucket type encircling the store. Thence the coal is carried, by another band conveyor, to a lipped-bucket conveyor which encircles the retort house and supplies coal to the overhead storage bunkers. This conveyor also receives coke direct from the base of the retorts, elevates it, and conveys it to the screening and grading plant and the storage hoppers, which are arranged at the end of the retort house.

Waste-heat recovery is a feature of modern gas-works practice of which the Colwyn Bay plant is an excellent example. The products of combustion from the retort bench are collected in an insulated flue and drawn through the tubes of a boiler specially designed for this duty. In this way about 4000 lbs. of steam per hour can be raised when the carbonizing plant is working on full load. The carbonizing plant is contained in a



The Glover-West Retort House: Coke Hoppers and Screening Plant.

building of steel-framed construction, panelled with bricks. The waste-heat recovery plant gives sufficient steam to produce the electrical power required by the installation, in addition to that required for the works auxiliaries.

POWER HOUSE, &C.

The power house contains two direct steam-driven exhausters, each of 50,000 c.ft. hourly capacity, and two direct steam-driven district compressors, each of 25,000 c.ft. hourly capacity at 5 lbs. per sq. in. pressure. (The whole of this plant was supplied and erected by Messrs. Geo. Waller & Sons, Ltd.)

The station meter is of the standard wet type of 50,000 c.ft. hourly capacity, erected by Messrs. J. & J. Braddock in 1923.

Storage is provided by three holders:

No. 1 telescopic column guided	. .	60,000 c.ft. capacity
No. 2 ,, ,, ,,	. .	200,000 ,, ,,
No. 3 ,, spiral ,,	. .	550,000 ,, ,,
Total	. . . . .	810,000 ,, ,,

Adjoining the purifiers is a "Retriever" pan ash plant for the recovery of coke from the pan ash.

The works are set out for an ultimate capacity of 2 million c.ft. per diem in 1 million per diem units, and thereafter capable of expansion in units of that size as the necessity arises.

WORKING RESULTS.

Since the commencement of gas-making under the new scheme, many economies, both in material and labour, have been effected; and the carbonizing plant has maintained results well up to the guarantee. The waste-heat boiler maintains steam for the whole of the works plant, in addition to supplying steam for the generation of electricity for the various motors.

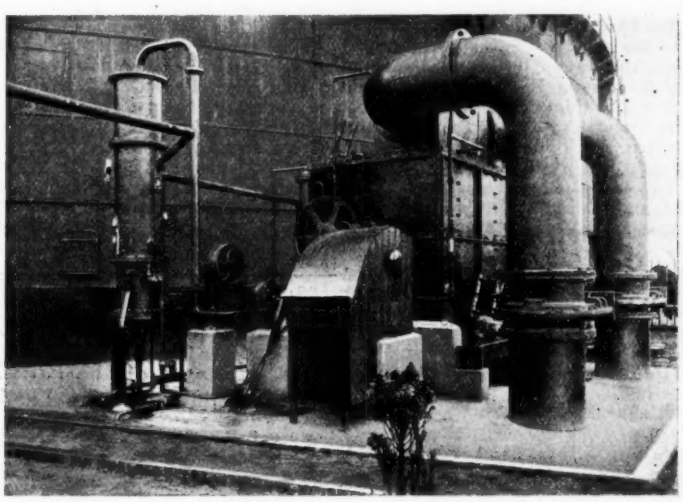
The following are the carbonizing results for the month of October, 1928:

Coal carbonized	963 tons
Gas made.	17,811,000 c.ft.
Gas made per ton	18,489 c.ft., or 85·7 therms

(The coal used was in equal proportions of slacks, washed singles, and nuts of South Yorkshire coals.)

"GLYCERIN" GAS DRYING PLANT.

A feature of interest is the plant which has just been completed for gas drying. It has been installed by Messrs. Kirkham, Hulett, & Chandler, Ltd.; the process used being the "Glycerin," a method recently developed by that Company. It is, we believe, the first plant of the type put to work on a commercial scale; and though the final adjustments and tests have not been completed, preliminary figures clearly indicate a humidity reduction of 65 p.ct. Already there has been a noticeable effect on the condition of the service mains and syphons; the latter being water-free throughout the district. A few details of the working of the plant are included below; and tests undertaken up to the present date clearly show glycerin to be a most satisfactory medium for the purpose of gas drying on a practical scale.



THE "GLYCERIN" GAS DRYING PLANT.

The plant consists of a four-chamber patent "Standard" washer scrubber, a Scott vacuum evaporator, cooler, and two tanks. The power is obtained from a small 3½ H.P. electric motor. The glycerin concentration plant consists of a patent tubular evaporator, specially designed to work under vacuum and to deal completely and automatically with the glycerin in circuit. It is guaranteed to work with a loss of not more than 0·25 p.ct. of the entering glycerin. The vacuum and withdrawal pumps are arranged close to the motor which drives the washer, and are operated by it. The combined power requirement of the two pumps is less than 1 B.H.P.

The method of working is simple, and the plant merely requires the minimum of attention given to other purification plant. At commencement, 82·7 p.ct. crude glycerin was placed in the plant; but continued working has shown that it is sufficient to have the glycerin concentration at 75 p.ct. in the inlet bay and 55 p.ct. in the outlet bay. A gauge on the top tank shows the quantity of concentrated glycerin in hand; and the evaporator is put into operation, when the tank is empty, concentrating and delivering directly from the lower tank containing the dilute glycerin. In the winter season it is found necessary to use the evaporator only during the day shift, every three or four days.

Working under the above conditions, the process gives a reduction of 65 p.ct. in the humidity of the gas, without trouble; a greater reduction being possible if a more concentrated glycerin is used.

ACCIDENT PREVENTION.

By A. STOKES, Joint Manager of the South Metropolitan Gas Company.

[Reprinted from the January issue of "Industrial Welfare."]

So long ago as 1892 the South Metropolitan Gas Company, recognizing that prevention is better than cure, instituted a system whereby every accident which necessitated absence from work for more than three days should be the subject of an inquiry by a jury of twelve workpeople.

Five years later a fund was inaugurated, known as the Accident Fund, which had for its objects:

(1) The prevention of accidents.
(2) The establishment of a scheme in substitution for the provisions of the Employers' Liability Act, 1880, and the Workmen's Compensation Acts, 1906 and 1923.
(3) To give prompt and certain compensation to employees incapacitated for work for at least three days by reason of accident in the course of their employment.

Every employee in receipt of weekly wages is entitled to become a member of the fund, and for the purpose of its administration each of the works and principal departments is treated separately. The rate of contribution, payable in advance for each half-year, at each works or department, is determined according to the number of accidents at that works or department in the preceding half-year, and ranges from 1d. per month per member, where the accident rate per 1000 members is 55 or more, to 1d. per six months where the accident rate is nil. These contributions are entirely devoted to the provision of benefits additional to the ordinary benefits, which, on the whole, exceed those obtainable under the Compensation Acts, and commence as from the date of the accident.

The managing body of the fund is the Co-partnership Committee, which consists of representatives elected by the workpeople, and an equal number of officials and foremen nominated by the Directors.

As the principal object of the fund is the prevention of accidents, the system of an inquiry into all accidents by a jury was continued. Each jury must include a member of the Co-partnership Committee, also a number of workpeople (but not more than four) from the department in which the injury occurred, the remainder being taken by rota from an alphabetical list of workpeople of at least three years' service. This jury calls and examines witnesses, visits the scene of the accident, and thoroughly investigates all the conditions and circumstances connected with the accident.

The presiding officer, who is usually the engineer of the works or head of the department, sums up, and the jury retires alone to consider and endeavour to agree upon a verdict. In the case of a fatal accident, the President of the Company or, failing him, one of the Directors, is the presiding officer. With a view to preventing similar accidents, the members of the jury must endeavour to arrive at the real cause of the accident, and, when they have done so, must state their honest convictions, not hesitating to say whether any blame attached to any official or worker, or whether the plant, machinery, or means of protection were defective, if they are satisfied that there has been any neglect, carelessness, or defect. They do so, of course, knowing that no one will be penalized except in the case of wilful misconduct. A summary of the proceedings, together with the verdict, is laid before the Board of Directors, and copies are also posted up in conspicuous places about the works.

All employees are requested to exercise the utmost care and forethought, and to report without loss of time any defects in plant or appliances to the foreman or engineer. All suggestions made in the interests of accident prevention, and all recommendations made by the juries, are, where practicable, carried out. Safety regulations are formulated, and disciplinary action is taken where they are wilfully or deliberately disregarded. Pictorial posters are regularly displayed to supplement the work of accident prevention.

In 1898 the proportion of accidents per 1000 subscribers to the fund was 82, and by 1914 this had been reduced to 38. An increase occurred, however, during the years 1915 to 1918 which was due to the exceptional circumstances of employment due to the war. There has been a steady diminution since, and the figure for 1927 was 32 accidents per 1000 employees. This result is attributed solely to the co-operative effort of employees, foremen, and management.

We should greatly resent any attempt to make accident prevention enforceable by statutory regulation. All enlightened employers recognize that the safety of their employees must be their first consideration, and that it is in the interests of both employers and employed alike that industrial accidents should be reduced to a minimum. Our experience of thirty-six years is evidence that a large number of accidents can be avoided by voluntary co-operative effort.

MODERN GAS SERVICE.

From a speech by W. M. Mason, Manager of the British Commercial Gas Association, before a gathering of Architects and Builders, at the Leeds Housing Exhibition on Jan. 24.

The lecturer, referring to the increasingly valuable co-operation of the gas industry with architects and builders in finding practical solutions to modern building problems, said that no better illustration of the progressive spirit in the gas industry could be found than in the fact that in connection with housing and health exhibitions—such as the very effective display staged in Leeds—local gas undertakings could always be depended upon to demonstrate the most up-to-date equipment available, as well as to render assistance on practical matters of installation. Leeds architects and builders were particularly happy in having a keen and up-to-date Gas Department run on most progressive lines, which had even gone the length of providing a permanent showroom for builders and architects, and had further fitted up houses, by special arrangement with builders, as practical demonstrations of good gas equipment. It was interesting to know that these had all readily found purchasers.

IMPROVEMENTS IN GAS FIRES.

Mr. Mason referred to the improvements in gas apparatus of all descriptions gradually evolved by science and practical experience. This had been an important factor in eliminating complaints, and in establishing gas equipment on an ever-widening foundation of satisfactory and reliable public service. Such points as the following, regarding gas fires, appealed specially to the architect.

Simpler and more artistic designs calculated to harmonize the appliances with any period scheme of decoration and furnishing.

No convected heat, or dust trap chambers.

Upright pillar radiants instead of piled-up ball fuel. Greater radiant efficiency of fire-brick and fuel.

Flue outlets capable of removing all the products of combustion, even if no flue pipe at all were attached to the flue outlet, or, at the maximum, a 2-ft. length.

Duplex taps.

Concealed supply pipes.

The architect and builder, continued Mr. Mason, had all sorts of building problems to solve. Regarding municipal schemes, where systems of lighting, heating, and cooking equipment were to a great extent standardized, gas was almost universal. The following facts were quoted on the point:

In a recent Glasgow housing scheme, out of 16,777 houses, 16,084 (or 95·27 p.ct.) were equipped for gas cooking, water heating, and room heating.

In Liverpool, where 13,000 houses have been erected, gas is installed in 98 p.ct. for cooking and 91 p.ct. for wash coppers. No fewer than 20,000 gas fires will be in use in that city's housing scheme.

In one London scheme alone, comprising 28,500 houses, gas is installed throughout for cooking and for lighting in over 22,000 of them.

GAS "ECONOMY" FLUES.

The speaker referred to the practical co-operation of many leading architects, particularly as regards "Economy" gas fire flues. Some points recently made by Mr. Walter Tapper, the President of the Royal Institute of British Architects, were of interest:

> The natural laws which govern the construction of coal flues also govern the construction of gas fire flues. There is, however, a fundamental difference between gas and coal as a fuel, and this affects the size of the flues necessary. Coal produces soot. Gas, on the other hand, is a clean fuel, and in ventilating it the flue area can therefore be made much smaller than that of the coal flue. A gas flue can, in fact, be made so much smaller that, by using special economy flue blocks, it can be constructed within the thickness of the party or external walls, rendering unnecessary the provision of a brick breast, and so providing additional floor and breathing space. Further, the concrete hearth of the coal fire can be dispensed with in the case of the gas fire, making trimming unnecessary. In these ways both material and labour costs can be appreciably reduced.

He understood that up to the present the Leeds building bye-laws did not permit flues of less than 9 in. by 9 in. capacity, but

with the rapidly growing use of gas fires in all types of modern buildings and houses he suggested that the authorities should recognize and adopt the gas "Economy" flue of lesser but adequate dimensions, and so reap the practical advantages briefly outlined in the statement by Mr. Walter Tapper he had just quoted.

OLD PROPERTY.

The conversion of old property to modern needs either for dwelling houses or for offices is a common building problem. In both cases, the prime necessity in making the buildings conform with the occupiers' and the architects' ideas of comfort, convenience, and economy, has been to abolish entirely all need for coal in the building. And in each case gas has taken its place. Be the office or the house never so old, the architect, the builder, and the gas expert, working together, can probably make it fit for habitation on approved 20th Century lines, and at a reasonably low cost.

Particulars were given on the modernizing of high-class London flats. The carrying-out of this policy involves the following principal items:

(1) The tiling or panelling of the walls and ceilings of the kitchens, larders, and pantries.
(2) The removal of the coal ranges from kitchens, and the tiling of recesses for the reception of modern gas cookers.
(3) The provision of gas-operated refrigerators as standard equipment in all flats.
(4) The provision of up-to-date glazed sinks with hot and cold water taps.
(5) The tiling or panelling of bathroom walls and ceilings.
(6) The provision of modern baths and basins with chromium plated taps.
(7) The running of gas supply pipes to every fireplace, to facilitate the fixing of gas fires.
(8) The heating of public landings and staircases by hot water radiators.
(9) The provision of one hot water radiator inside the entrance to each flat.
(10) A constant supply of hot water to each flat, for baths and domestic purposes, and for heating the radiator. This hot water service is provided from a central source, and is paid for in the inclusive rentals charged for the flats.

By such means, said Mr. Mason, property owners are steadily improving the capital and rental value of their property, and making their flats particularly attractive to the modern woman.

THE NATION COOKS BY GAS.

The speaker could only briefly refer to the part gas service played in the equipment of modern stores and shops, hotels and boarding houses, cinemas, churches, and halls. In proof of the fact that the Nation's cooks use gas, he referred to the recent great Cookery and Food Exhibition held at Olympia, where every aspect and phase of cooking, from the most elaborate hotel and restaurant dishes to simple meals for the average household, were covered.

Encouragement was given to professional cooks, apprentice cooks, domestic women cooks, amateurs and housewives, Army and Navy and Mercantile Marine cooks, hospital nurses, and Guides and Scouts to take part in competitions. A large number of demonstration lectures were also given by well-known English and Continental chefs, and by the experts of the Empire Marketing Board, in several large theatres, which were more often than not crowded to capacity with from 100 to more than 500 people at a time. Many exhibitors, too, gave practical demonstrations of the preparation and cooking of their patent food products on their stands.

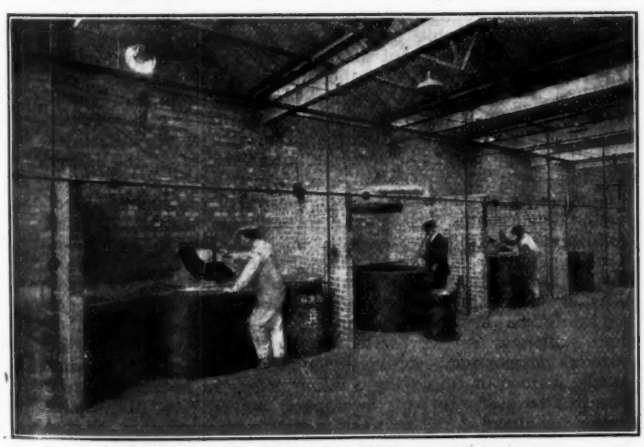
It followed that "an exhibition of how things should be done" depended for no small amount of its success on the cooking appliances used. And in this latest and largest Cookery and Food Exhibition the striking feature was the almost universal use of gas cooking appliances not only in the demonstration and competition theatres, but on numerous stands of exhibitors.

GAS IN THE MANUFACTURE OF PAINT AND VARNISH.

From the January issue of the Gas Light and Coke Company's Co-Partners' Magazine.

Linseed oil is the basis of both paint and varnish, though in the manufacture of the latter some kind of resinous substance—different manufacturers favouring different kinds of gums—is also needed.

Before it is ready for use, the raw oil has to be prepared or refined, and for this purpose it is brought up to the boiling point in an iron or copper vessel, and is maintained at that point for a protracted period until the impurities and some of the moisture are eliminated. A gas-fired furnace has been specially designed to carry out this duty. Gas at ordinary pressure and air blast burners are used, the flames from the burners playing on to a bed of refractory material, which in turn imparts its heat to the vessel. The furnace is fitted with brick baffles, to secure the correct diffusion of heat and to increase the duty obtained from the gas consumed, and the burners are so arranged as to permit of a maximum or minimum temperature being obtained at will by the simple manipulation of the control taps.



A Section of a Gas-Heated Installation for Oil-Boiling.

After the prescribed period of boiling, what are known as "dryers"—substances which ensure the quicker drying of the solution when it is spread out in thin layers on a surface—are added, and the mixture is again boiled for two or three hours, after which it is allowed to cool down and settle.

The prepared oil is then poured into tanks, where it is allowed to remain for a week or two, in order that the dryers which have not been taken up by the oil may sink to the bottom. The oil is then ready to be mixed with colouring matter for paint, or else to be used in connection with varnish making, which we will now consider.

The heating processes connected with the manufacture of varnish present a number of difficulties, as the gums vary in hardness, and the temperature at which they can be made to mix with and dissolve in oil accordingly ranges from 450° to 800° Fahr.

The gum is first melted in a copper vessel—copper being used because of the very high temperature which is required—and is then heated to the required degree. At the same time the prepared linseed oil is heated to boiling point in a separate vessel, and when the oil and gum reach a specified temperature, a certain quantity of oil is added to the liquefied gum. The mixture is then boiled together until it becomes clear, further quantities of heated oil being added from time to time until the solution reaches the required consistency. It is then allowed to cool down somewhat, and a proportion of turpentine is added.

Up till about ten years ago, solid fuel was almost exclusively used as the heating agent for this process, though certain experiments had been carried out with gas as the fuel. In 1918, however, we succeeded in obtaining permission from one of the largest varnish manufacturers on our district so to convert their hard fuel installation as to permit the use of gas.

The furnaces were partly reconstructed and their ventilation rearranged so that the highest possible degree of efficiency could be obtained from the gas consumed. At first the burners were placed below the bottom and centre of each pot, but it was found that this method was not all that could be desired, because when a pot of varnish is completed, it has to be taken outside the varnish house, and placed upon the ground to cool, after which the contents are emptied into a tank, and the pot is re-charged and returned to the furnace. After being heated by gas and placed outside, it was found that a pot collected all sorts of foreign matter on the hot bottom, with the result that when it was returned to the furnace, carbonization set up, and in time the burner became almost completely choked.

Another fault which revealed itself in this method of heat application was that the top plates of the burner—which was actually situated in the combustion chamber beneath the pot—were subjected to very high temperatures, which caused them to buckle. The result was that the joint was broken, and the flame came through the side of the burner, and set up what is termed "spot heating," *i.e.*, excessive heat on one portion of the pot. This meant that the working costs of the gas-fired installation compared unfavourably with the solid fuel furnaces, owing to the large increase in the cost of repairing pots,

To overcome these difficulties further experiments were carried out at our Industrial Appliances Workshops, and the furnace which was eventually designed proved so satisfactory that the firm decided to adopt gas-fired furnaces throughout their extensive works for this duty, to take the place of the whole of their solid fuel installation.

In the new furnaces the burners are designed to work with gas at normal pressure and air at 10 in. water column pressure, the air being supplied from an air-blower driven from a power plant, which was already in use in the factory.

The burner is fixed in the front side of the furnace, instead of beneath the combustion chamber, and is so arranged that the flame projects across the bottom of the pot, which does not itself foul the burner. The flame skims the bottom, splits, and returns round each side of the furnace, and the products of combustion then discharge into a flue through ports which are situated at each side of the furnace opening.

In all paint and varnish factories special precautions have to be taken against risk of fire, because of the very inflammable nature of the substances which are handled. In most cases each furnace is partitioned off by brickwork, so that if one pot should " flash " the trouble can be speedily dealt with, with no fear of its spreading to the next pot, or a serious fire occurring.

In this connection also, the use of gas can claim distinct advantage over solid fuel, because in an emergency the gas to the furnace can be immediately turned off, and the door of the hood over the furnace closed. It is important to state, however, that the ease with which the heat from the gas can be regulated has reduced the possibility of " flashing " to a minimum.

In conclusion, to illustrate one of the Smoke Abatement Society's arguments, mention must be made of the smoky, grimy conditions in which paints and varnishes are made in those factories where solid fuel is still in use, and, by way of contrast, it is worthy of note that in the varnish house of a firm whose oil boiling and varnish making furnaces have recently been converted to gas firing, the walls have been painted art pink, the air supply to the furnaces in aluminium, the gas supply pipes red, and the floor round the furnaces whitened. The contrast may easily be visualized.

An Overhead View of a Pit Furnace Used in the Manufacture of Varnish.

OIL PRODUCTION FROM COAL.

Extract from a Paper by Harald Nielsen, Technical Consultant to Sensible Heat Distillation, Ltd., before the Second Bituminous Coal Conference held at Pittsburgh in November, 1928.

The question may rightly be asked, when the oil produced from coal by employing a very large volume of gas as the distilling medium appears to be superior to that produced by a lesser volume, why not use the large volume? Theoretically, everything speaks for it; practically, there are difficulties. First, there is the question of heat economy. The gas used as the distilling medium must enter the system at a certain minimum temperature, about 600° C.; otherwise the temperature difference between the heating gas and the coal is too small for efficient heat transfer. The amount of heat required to distil coal is something on which a great divergence of opinion exists. From careful observations conducted over a number of years and dealing with thousands of tons of coal, I feel inclined to assert that the heat requirements are very much smaller than we have been led to believe in the past. For instance, when treating bituminous coal of a younger formation, containing from 12 to 13 p.ct. of O_2, we have efficiently distilled this by employing a gas volume of not more than 1 to 1·2 cub.m. per kg. of coal. This gas, with a temperature drop of from 650° to 200° C., only gives up 135 kg. cal. per cub.m. at N.T.P. volume basis. This quantity of heat also covered the radiation and convection losses from the retort. Considering the heat carried away by the solid residue, leaving the system at 450° to 500° C., and the evaporation and superheating of from 5 to 6 p.ct. of free moisture, there is a deficiency of kg. cals. which at first glance renders the heat-balance nonsensical. Well, the extra heat can, in my opinion, only be supplied by the exothermic reaction in the coal substance itself, commencing at temperatures as low as 200° to 250° C., resulting in the formation of CO_2 and combined H_2O. Nobody knows how the oxygen is combined in the coal substance; but what I suggest is that, once the coal substance is heated up to 200° to 250°, and in some cases 300° C., by the heating gas or by conduction (as in the case of externally heated retorts), the exothermic reactions come into play and carry on the good work to finality. I will admit the boldness of this assertion, but it is, it seems to me, the only plausible explanation.

The volume of gas required to carry the heat to distil bituminous coal is very much less than that conducive to good oil. We find that about 2 cub.m. represents the happy mean and corresponds, at a gas producer efficiency of 80 p.ct. and a combustion chamber efficiency of 85 p.ct., to about 300 to 310 kg. cal. per kg. of coal. Taking raw coal as having a heating value of 6700 kg. cal. per kg. (12,000 B.Th.U. per lb.), the fuel requirements would, therefore, be 4·6 p.ct. by weight of the raw coal (theoretical). Taking 7 cub.m. per kg. of coal, we have under the same conditions 16 p.ct. by weight of fuel. The difference in the oil quality does not in my opinion justify the extra fuel expenditure.

Does it not strike anyone working out a thermal balance between the heating value of the raw coal entering the retort and the sum of the heating values in the resultant coke, oil, gas, and ammonia that, however careful one is in computing the figures, there is always a loss unaccounted-for of from 5 to 10 p.ct., and even higher, of the heating value of the original coal? I believe that this loss in heat is that evolved by the exothermic reactions of the coal substance, and is the energy that effects the carbonization, and that the fuel we put into the system only starts the operation. We are now carrying out further work on this highly interesting subject, which I hope to make public shortly. It has been observed on numerous occasions that the younger the coal to be distilled, the greater the so-called unaccountable thermal loss in the heat balance between latent heat units put in and latent heat units recovered. This seems to coincide with the higher exothermic properties exhibited by such fuel during distillation. Another reason against the use of a very large volume of gas is the cost of power consumed in circulating this large quantity, and the difficulties in providing adequate condensing plant to recover all the lighter oils.

It will be clear that the greater volume of gas meant a proportionately greater gas velocity through the retort; the area of free suction or gas passage being the same in each case. Hence the gas speeds were 3½ times greater. It stands to reason that by diminishing the sectional area of the gas space the possibility of obtaining the same gas velocity with 2 cub.m. of gas per kg. of coal as with 7 cub.m. of gas exists; and since more than sufficient heat is carried by the lesser gas volume, the rational development would go in that direction. In other words, instead of employing a filling degree of 20 p.ct. and free space of 80 p.ct., 40 p.ct. free space and 60 p.ct. filled space should be aimed at. Care must, however, be taken that the coal under treatment does not act as a Pelouze or impact scrubber for the oil vapours in the colder parts of the retort. The outlet temperature of the gas, of course, should always be well above the dew-point of the heaviest fractions.

By employing 2 cub.m. of gas per kg. of coal, no troubles are experienced in recovering 95 p.ct. or more of the total oil evolved. The oil we obtain is considerably richer in the heavier viscous oils than that produced by externally heated retorts, and correspondingly poorer in light oil and spirit fractions. This is, of course, of great assistance when scrubbing a large volume of gas containing a relatively small concentration of oil. It will be understood that when little spirit is formed, the losses cannot be great. The mechanism of the production of lighter oils by the cracking up of the primary heavy oil has only been very imperfectly understood; hence the objections raised in different quarters to the employment of distillation with internal heat.

YORKSHIRE JUNIOR GAS ASSOCIATION.

Members of the Yorkshire Junior Gas Association gathered on Saturday, Jan. 19, to the number of 71, at the Halifax Corporation Gas-Works in Mulcture Hall Road, Halifax, to make an inspection of recently installed vertical retort plant, and to hear a paper by Mr. J. W. Denton (Assistant Distribution Superintendent to the Halifax Gas Department) on the subject of "High Pressure Governors and Plant."

During the early part of the afternoon the visitors were conducted over the newer portions of the retort plant. Mr. W. B. McLusky, Gas Engineer and General Manager, welcomed the party, and apologized for the absence of Alderman J. H. Waddington, the Chairman of the Halifax Gas Committee.

Mr. McLusky accompanied the party over the works, and helped the guides freely in explanations and the answering of questions. The guides were Messrs. Howard Leach, Manager's Assistant; James McBain, Mechanical Engineer and Superintendent of Works; Leslie Pickles, Chief Chemist; and Morris Bradley, Chief Draughtsman.

Since the Yorkshire Junior Gas Association was last at Halifax there has been completed the second installation of vertical retorts by Messrs. Drakes Ltd. The gas supplied to the town to-day is all by the vertical retorts. The second vertical installation is of 32 retorts in four beds of eight. The earlier installation, completed in 1921, was of six beds of eight retorts. The first section were 3-ton retorts, but the newer ones are of four tons. The new set was completed at Easter, 1928, and has been working ever since. The Halifax Gas Department, it was pointed out, is to-day selling 7000 threepenny bags of smokeless coke fuel from these vertical retorts per week—through the agency of 73 local shopkeepers.

After light refreshments the business meeting was held in the Committee Room at the works; Mr. S. H. PACKER (Bradford, President of the Association) presiding.

Mr. PACKER congratulated the members on their enthusiasm, and particularly on their appreciation of their colleagues at Halifax, which had prompted such an excellent attendance that day. He regarded the attendance as a very hopeful augury for the new working year of the Association. It was always a great pleasure to visit an undertaking which, in many ways, was distinctive, and whose remarkably progressive character must ever remain a monument to the skill and ingenuity of Mr. W. B. McLusky.

On the motion of the PRESIDENT, the gathering rose in respectful sympathy with Mr. McLusky in the bereavement he recently suffered by the death of his mother.

Mr. MCLUSKY, offering a formal welcome to the gathering, said he was always glad to meet the Yorkshire Juniors, because he found it an inspiration to be with them, to see the evidence of their enthusiasm for their profession, and to hear them discuss problems of the industry. The Yorkshire Junior Association, with which he had had a close comradeship for a good many years past, occupied a very dear place in his heart, and the welfare of the young men in the profession was a matter in which he would always have the keenest interest.

HIGH-PRESSURE GOVERNORS AND PLANT.

By J. W. DENTON, of Halifax.

The high-pressure gas supply system in Halifax is made use of in different ways, briefly as follows: To supply high-pressure gas, to carry gas at high pressure to distant places, or to boost low-pressure mains.

In addition to the ordinary low-pressure system there is a direct high-pressure supply covering the main thoroughfares of the town. This supply is used for street lighting, shop front lighting, and industrial users.

In the second method, high-pressure gas is sent direct to an outlying village, five miles distant from the works, where the gas is governed down to low pressure, and then distributed in the normal manner.

A 4-in. diameter Mannesmann steel main is used for this purpose. The gas is fed to the main at an inlet pressure varying from 2 lbs. to 2·5 lbs. per sq. in. This pressure is governed at the works end of the pipeline by a set of Bryan-Donkin high outlet pressure governors. The alteration in pressure is effected in this case by spring-loaded secondary governors, and is varied only to suit seasonal demands. The consumption at the distributing end of the main is regulated by a set of "Equitable" governors, and at times of maximum demand is 4000 c.ft. per hour. This consumption causes a drop of pressure between works and district of approximately 1·51 lbs. per sq. in. Taking actual pressures and consumptions, and using the modified Unwin's formula,

$$Q = 32{\cdot}2\ \sqrt{d^5} \times \sqrt{\frac{h_1^2 - h_2^2}{Ls}}$$

where

d = diameter of main in inches
L = length of main in miles.
h_1 = initial pressure in lbs. per sq. in. Absolute.
h_2 = final pressure in lbs. per sq. in. Absolute.
s = specific gravity of gas, compared with air.

the comparative measured consumption and the calculated consumption were 3000 and 3170 c.ft. respectively; the loss of pressure in this case being 0·7 lb. per sq. in.

By a third means, high-pressure gas is carried through an isolated stretch of country supplying *en route* farms, hamlets, &c., by means of high-pressure services and service governors. A 4-in. steel main has been laid for this purpose; and working with an initial pressure of 3 lbs. per sq. in., this main will give the same discharge as a 10-in. low-pressure main working with a pressure loss of 1 in. W.G. The saving effected by the use of the smaller main more than repays us for the additional cost of service governors, &c.

On this particular system we have 72 service governors supplying isolated buildings, and 14 trunk service governors, each supplying rows of cottages. At the end of this main a 4-in. Reynolds governor is fixed to supply a village containing approximately 200 gas consumers. The house service governors mentioned above are of the usual Bryan-Donkin type, and all are fixed on the inlet of the meters; the meter cock being fitted at the inlet to the governor. The trunk service governors are fixed in pits in the roadway.

In passing, I should like to add that it is essential to see that the governors are so designed to enable the top cover and diaphragm to be removed without disconnecting the service.

The fourth use for high-pressure mains has enabled us to make connections from this main into the low-pressure mains at various points. On each of these branches a governor is fixed, and loaded to maintain the required pressure in the district mains. This method has saved us the expense and trouble of increasing the sizes of certain low-pressure mains to meet the demand caused by extensive building operations in various districts.

For a fifth use, gas is boosted from the works holder to the gasholder station one mile away. An 18-in. cast-iron main is used in this case; the pressure being raised to 15 in. W.G. by means of boosters driven by Aster four-cylinder petrol engines running on coal gas. The boosting fans, working at 2000 R.P.M. are capable of moving 220,000 c.ft. of gas per hour against a holder pressure of 10 in. W.G. From this 18-in. main, as it leaves the works, a connection is taken to the inlet of the compressing plant as an alternative to a supply taken from the 24-in. district main.

COMPRESSING PLANT.

The inlet main to the compressing plant must be of ample proportion, and the connection should be made to the holder outlet main before the station governor. This was not practicable in our case; the supply being taken from a 24-in. district main passing close to the works.

A by-pass was arranged so that gas could be taken, if necessary, through the inlet connection from the holder supply trunk main. Considerable trouble has been experienced in preventing the oscillation caused by the compressors being transmitted to district mains. Gas is supplied almost at the point where the connection is taken for the high-pressure plant, so that it was necessary to have a very efficient anti-fluctuator to prevent the oscillations being troublesome. The general design of the anti-fluctuator in use is shown in the accompanying diagram. Difficulty arose through the "hunting" of the valve; for while it was necessary to have gas acting on the anti-fluctuator diaphragm, it was this action that caused a violent jumping of the anti-fluctuator spindle. Weight loading on a lever was found to assist this jumping, due probably to the fact that the inertia of the weights and the apparatus, instead of stopping the oscillations caused by the plant, set up secondary pressure waves. A plate was accordingly fixed in the body of the apparatus below the diaphragm, and outlet gas was allowed to actuate the diaphragm through a needle valve. A dashpot has also been fixed on the low extremity of the spindle, to assist the damping action.

At Halifax we have two steam-driven compressors, both by the Bryan-Donkin Company. One is a reciprocating single-stage compressor capable of delivering 30,000 c.ft. of gas per hour at 310 R.P.M. against a pressure of 20 lbs. per sq. in. The other machine is a steam-driven set of two rotary compressors of the two-blade block-driven type having a capacity of 15,000 c.ft. per hour, each at 200 R.P.M., against 5 lbs. per sq. in. Both engines are controlled by diaphragm steam regulators, so that any determined pressure may be maintained at the outlet. Arranged between the inlet of the compressor and the outlet are two connections. One is to pass gas through an excess pressure valve from the high-pressure main to the low-pressure side, in case any excessive pressure is reached. This will occur when there is very little consumption, and the engine running at its lowest speed is compressing more gas than is required. The other connection is an automatic by-pass valve to allow gas to feed into the high-pressure mains in case of stoppage to the plant.

An electrical alarm gauge is fixed in the compressor house as a further precaution, so that, in the event of the plant failing to maintain the determined pressure, warning is given before the gas receivers are empty. The quantity of gas compressed

is 29 million c.ft. per year, and the cost of compression (including maintenance and fixed charges) is 0·96d. per 1000 c.ft.

RECEIVERS.

The compressed gas is stored in two converted 30-ft. Lancashire boilers placed outside the compressor house, and provided with valves so that both, one, or neither may be used. The effective storage capacity of these receivers varies directly as the pressure above atmosphere. Working at 30 lbs. per sq. in., this would give a storage capacity in our 8-ft. diameter storage cylinders of 3070 c.ft. of gas. Under certain conditions the gas receivers are useful as water separators. One system of working them is to charge the receivers with gas at a pressure of (say) 30 lbs. per sq. in., cool the gas at this pressure, and allow it to pass to the district through high-pressure outlet governors set at about 5 lbs. per sq. in. In this way trouble from naphthalene and condensation is in a large measure eliminated. At Halifax it is possible to use the high-pressure receivers as a water separator, on account of their exposed position. This cooling of the gas is essential to efficient water extraction.

Speaking generally, the capacity of gas for moisture varies, at constant temperature, directly as the volume, and inversely as the Absolute pressure. Assuming that the gas enters the compressor at 60° Fahr., and leaves the receivers at 70° Fahr., the quantity of water condensed per million c.ft. of free gas corrected to 60° Fahr. and 30 in. mercury will be 45 gallons. This figure has been obtained by calculation from the following formula (Woodall and Parkinson's):

$$Q_t = 0{\cdot}0375 \times \frac{A}{29{\cdot}92} \times \frac{672}{T} \times \frac{10^6}{10} \times \frac{T}{520} \times \frac{30 - a}{P - A}$$

where

0·0375 = weight in lbs. of 1 c.ft. of steam at 212° Fahr.
A = pressure of aqueous vapour in inches of mercury.
a = pressure of the aqueous vapour at N.T.P.
T = Absolute temperature of the gas, ° Fahr.
P = Absolute pressure in inches of mercury.

This quantity of condensation—*i.e.*, 45 gallons per million c.ft.—does not represent the total amount of condensation collected in the receivers. During the compression of the gas its temperature is so raised as to increase greatly its affinity for water. In this under-saturated or dry state the gas will readily absorb any steam which may chance to pass from the cylinders into the gas compressing chamber. This vapour, along with some light oils which fall down, constitutes the condensate collected in the gas receivers.

GOVERNOR DIAPHRAGMS.

These are of Persian sheep skin treated with an absorbed vegetable oil containing refined tallow. The skins are bought, and the diaphragms cut as required. A stock is always kept ready for emergencies. The dry skin is cut to size, taken to the governor pit, and then treated with oil when fixed in position—thus ensuring a reasonable chance of keeping the leather free from grit. The diaphragms in the Reynolds governors are liable to wear on the inner circumference of the annular binding ring; this being due in many cases to the sharpness of the edge of the ring. This edge should be turned in the lathe so that the cutting action is reduced to a minimum. It is at this part of the diaphragm that no oil can be worked into the leather during the ordinary maintenance visit.

For use with extra high pressures, two leather diaphragms are used with an interposed diaphragm either of fine silk or rubber. This is necessary to make the diaphragm impervious to high-pressure gas, and to ensure its standing the strains to which it is subjected.

Rubber and canvas composition diaphragms have been experimented with on the district governors, but no success has attended these trials. The diaphragms worked very satisfactorily as regards strength and flexibility, but they have one serious disadvantage. No mineral oil must be allowed to fall on them, or the rubber will dissolve, and a gas leakage occur through the canvas. It was found that, even with care, it was impracticable (despite the use of thin metal shields) to lubricate efficiently the working parts of the governor, and yet keep oil from the diaphragm. These rubber diaphragms lasted on an average only six months, as compared with the average life of six years for a leather diaphragm. The costs of rubber and leather diaphragms are about the same.

GOVERNOR PITS.

These may be divided into three classes:

(1) The governor house at the side of the road, in which is installed the governing plant, where maintenance must be ideal. The cost of providing the house and finding the suitable space often makes this type of sub-station impracticable.

(2) Providing a site is procurable, a cast-iron kiosk may be built on the surface of the road, the walls of which are easily removable to gain access in order to repair the governing plant.

(3) The usual method is to have the governor in a pit below the level of the road. This has the one advantage of making a straight connection, but the choice is made on account of the difficulty in finding a surface site.

The following points should be noted in designing governor pits:

There should be sufficient room for a man to gain access, work in, and be able to get out quickly; and steps or wall brackets should be provided to facilitate this.

The floor of a pit should fall at least 3 in. to one corner of the pit, and a sump should be provided at this point no less than 18 in. deep.

The floor should be concreted, but the bottom of the sump, unless definite drainage is carried out, should be of rubble. The walls of the pit, if built of brick, should be finished with a coating of "pudlo" cement.

If the main is in the footpath, and very shallow, the governor pit should be provided with covers carried on removable bearers, so that the whole area of the pit may be exposed when required.

The walls of the pit must not be built on the gas main. A definite opening must be made in the wall for the main.

Pits for service governors should be large enough to allow a long thread on the inlet and outlet sides of the governor to be uncoupled without difficulty. The pit bottom in this case should not be concreted, but should be neatly finished with fine rubble. The vent pipe from the top of the diaphragm must be carried to a point near the roof of the pit; otherwise, should the pit become flooded, water may find its way into the loading chamber, and seriously affect the working of the governor.

GOVERNOR MAINTENANCE.

The recorder is a very useful instrument to the governor maintenance staff. Apart from the provision of points for fixing mercury or water gauges, there should always be provided a recorder at every main governor. The uses of the recorder may be classified as follows:

(1) Showing faults in the governor which would not be found by normal inspection.
(2) Detecting small faults in the governor, which on being corrected save possible stoppages.
(3) Showing mistakes made during overhaul, changing-over, and maintenance visits.
(4) Detecting mistakes or faults in the compressor house.

The usual faults in high-pressure governors are:

(1) Violent oscillation of the governor valve.
(2) Banking of pressure at no-load periods.
(3) Freezing or condensation troubles.
(4) Variations of outlet pressure.

Violent Oscillations.—These occur chiefly in high-pressure governors where the duty is to reduce the pressure from 30 lbs. per sq. in. to 5 lbs. per sq. in. A "chattering" takes place in the first governor which causes the secondary governor to vibrate in sympathy. While the vibration of the governor does not seriously affect the outlet pressure, it does much damage to the valves and seating. What actually happens is that the governor spindle is drawn slightly out of the vertical by a badly fitted diaphragm, and accordingly one side of the valve becomes seated before the other. This causes the "chattering," which may become so bad that the governor valve spindle is broken or the seating badly damaged. These governor seatings are arranged so that they may be renewed. To cure the above-mentioned fault, the diaphragm must be fixed truly central, and the diaphragm plate lock-nuts on the spindle lowered so that the valve may seat before the diaphragm tightens.

Banking of Pressure.—In the type of governor containing two valves, great care must be taken to ensure that both valves seat together. To do this, the distance piece between the two valves must be adjusted so that a thin strip of paper is firmly held between each valve and its seating. If the governor is set correctly, dirt may accumulate on the seatings, and cause leakage of gas over the valves. Some undertakings have found it necessary to fix screen boxes at the inlet to the governors; the rust dust being collected on a fine mesh. Fortunately, Halifax has not had need to do this; very little rust having been collected from the governors during overhaul. Great care is taken, however, to see that no oil falls on to the valves, and they are inspected and cleaned once each month.

Freezing and Condensation.—Every governor should have a drain cock at the lowest point, to allow condensation to be removed; and the high-pressure governors at the works should be syphoned every morning. With high-pressure outlet governors, the auxiliary system is the one in which most difficulty is experienced with condensation; a very small amount being sufficient to cause a varying outlet pressure. On the district the trouble with freezing in governors has only occurred when water has leaked into the loading chamber. If the pit

cannot be corrected to prevent this, it is wise to pour a liberal amount of glycerine on the top side of the diaphragm.

Variations of Outlet Pressure.—These may be caused by almost any fault in the governor; the common ones being:

(1) Wrong adjustment of auxiliary system in relation to main governor setting. This causes a drop or an increase of pressure when the main governor comes into action.

(2) Burst or leaking diaphragms, occurring particularly in the compensating bowl.

(3) Auxiliary governors sticking—often caused by dirt or water.

(4) Main governor valves sluggish, due to binding of the spindle, or the leather on the valve, being softened with oil, sticking to the seating. This latter would cause a drop in pressure on a sudden increase in consumption.

(5) Excess pressure valve faults, allowing gas to pass into the low-pressure main before the pressure at the outlet of the governor is dangerously high.

MAINTENANCE.

Maintenance is carried out by a specially trained fitter assisted, when required, by an apprentice. The alarm gauges and high outlet pressure governors are inspected daily; syphons being emptied, and pressures taken. Weekly visits are made to every district and trunk service governor, when charts are changed, the pit is opened up and pumped clear of flood water, and the inlet and outlet pressures are noted. If the sets are in duplicate, they are changed over. Once every month the governor diaphragms are oiled; the oil being worked into the leather by hand, to eliminate any chance of a weak diaphragm remaining undetected. The valve plates are taken off, and the valves examined. Every year the governors are stripped completely, overhauled, and built up again. Overhauling of the service governors is carried out once per annum, with an inspection every three months. A record is kept of each visit; any alteration or adjustment made being noted.

Discussion.

Mr. MCLUSKY, invited by the Chairman to open discussion on the paper, said he felt that he, as the Halifax Gas Engineer, should not say anything which might in any way influence or prejudice opinions or ideas in the minds of those present. He would, however, like to congratulate Mr. Denton on the value of his paper, and on the excellent manner of his delivery. Mr. Denton was a splendid tribute to the training and influence of Mr. W. Heathcote, the Distribution Superintendent of the Halifax Gas Department—one of the Yorkshire Junior Gas Association's Past-Presidents, and a man for whom they all had the greatest esteem.

Mr. J. W. CARLTON (Shipley) asked if Mr. Denton had any appreciable amount of trouble with condensation on the district beyond the compressing plant. If so, did he put syphons in his high-pressure main? Did he get corrosion in the main governors, and, if so, how did he deal with it?

Mr. DENTON replied that the high-pressure syphons were attended to four times per year. That was all they found necessary, and even that would not be the case but for their determination to make certain of avoiding any possibility of trouble. There was practically no condensation on the district. In regard to corrosion on the main governor supplying the village to which he had referred in the paper, and the cottages and farms *en route*—a matter of approximately two miles from Halifax—there was a mere handful of dust every year, no more than about 6 ozs.; and that had all fallen to the bottom of the governor. It caused no trouble, because the governor and valve seating were kept clean and quite free from oil.

Mr. CARLTON remarked that he himself had had some experience with high-pressure installations, and found there was trouble with corrosion in the steel main, and they had to clean the main governor out once per month. They had to put in a catch box in the main chamber. The matter carried forward was so fine that it got through on to the base of the valves, however much care was taken that no oil reached the valves themselves. In regard to condensation, in his case they had one large syphon just outside the receiver, which had to be pumped once per week.

Mr. DENTON said that when he mentioned the 6 ozs. of rust per year, he was referring to a main governor. He thought that good result could only be attributed to their getting rid of the moisture before the gas left the works. The questions of condensation and corrosion were, of course, closely allied; and by getting rid of moisture before the gas left the works, it was possible to avoid much corrosion trouble on the district.

Mr. T. R. MORTIMER (Brighouse) asked if the governor diaphragms had to be renewed frequently, or if the system of oiling lasted for some considerable time, in Mr. Denton's case.

Mr. DENTON replied that his governor diaphragms lasted six years. He thought that was a good average life, and it was due to keeping the diaphragm well covered with oil. Each time the fitter went to the job he lubricated the diaphragm.

Mr. C. T. B. ROPER (Bradford) asked if the house governors were fixed inside the premises or in a little pit outside. He presumed the lids were not sealed, and wondered if the vent pipe mentioned in the paper was sufficient to get rid of any gas that might come out, or if Mr. Denton had had to consider the question of carrying the vent pipe outside the building. He believed the Leeds Gas Department had a high-pressure installation—not quite so high as that of Halifax—and that Leeds provided a good-sized vent out of the pit, on to the footway, and up the side of the building. They also, he believed, had some trouble with corrosion, and had to provide screens.

Mr. DENTON said the manhole covers were not sealed. The vent pipe was not to carry gas away from the governor pit, because no gas leaked out of the governors. It was a vent pipe on the top side of the diaphragm, so that when the diaphragm emptied there was no compression of air in the top side. If the diaphragm was going to move freely, it must not be damped by compressed air above it. At Halifax they had not found it necessary to fix a vent pipe such as Mr. Roper seemed to indicate was in use at Leeds. They had only had one complaint of governor pits smelling, and that was largely due to a case of bad drainage at that particular point, and possibly to dirt having got into the governor pit.

Mr. H. WADSWORTH (Harrogate) thought the subject of condensation on high-pressure plant was a difficult matter on which to attempt to dogmatize. On the district with which he was concerned they had about 18 miles of high-pressure mains, and they found a certain amount of trouble with condensation about 6 miles from the works. He thought, perhaps, varying pressures at the works were liable to give condensation on the route. In his case they took charts, and found them very interesting, but even with such charts there was a question as to when they might be liable to become misleading. In regard to house service governors, Mr. Denton had said he put the service governor on the meter. Did he have to go through the wall to take the vent into the atmosphere? At Harrogate they put the service governor outside the house, and took the safety vent up the outside of the wall.

Mr. DENTON replied that where possible they fixed the governor outside the house at Harrogate, but in quite a number of cases the service governors had to be fixed inside. The meter cock was on the inlet to the governor, and the consumer was told to turn it off if ever he smelled gas. Every governor was passed and approved by the fitter as he went by each week. They had a very happy spirit of co-operation between the fitter and the consumers, and they were able to report any slight trouble readily. At Halifax they did not fix a mercury seal, because they felt there might be danger from a mercury seal blowing, and a light getting to the gas outside the building.

VOTES OF THANKS.

Mr. S. T. S. MUSGROVE (Sheffield), proposing a vote of thanks to Mr. Denton, said the experience of the reader of the paper on the subject of high pressure coincided very generally with his own. He felt that the excellent results obtained at Halifax were due mainly to two things—first, the care with which the installation had been put in; and, secondly, to the excellent system of maintenance that was in operation. The question of maintenance on high-pressure work was of primary importance. Given an efficient maintenance system, he agreed with Mr. Denton that there should be comparatively little trouble. Mr. Musgrove said he had been very interested to hear the various remarks on condensation. His own experience was similar to that of Mr. Denton. If one took the moisture out at the works—which, of course, was the proper place to take it out—the trouble from condensation on the district should be reduced to a minimum. He entirely agreed with the speaker as to the close relationship of condensation and rust dust. Troubles on the district were going to be much reduced in the future where dry gas plants were installed. Mr. Musgrove said he had been a little surprised to hear a speaker refer to condensation trouble 6 miles from the point of compression. He had never heard of such a thing before, and it would be extremely interesting if that matter could be further investigated. At Sheffield they had 15 or 16 miles of high-pressure main, and it was very rare indeed that they got any condensation worth mentioning, apart from that collected at the works. He was hardly able to agree with the suggestion that varying pressures were liable to cause condensation 6 miles away.

Mr. CARLTON, seconding the vote of thanks, said the paper had been an excellent one, and had provoked an interesting discussion. It was a paper by one of their younger members, and it gave further proof of the fact that the Association had in its ranks a number of men capable of giving valuable papers, if only they could be persuaded to "come out of their shells." As one who had had some experience with high-pressure systems, he thought Mr. Denton was fortunate in having one which gave such remarkably little trouble. This gratifying freedom from trouble must be due, as Mr. Musgrove had remarked, to the excellence of the installation and the extremely efficient maintenance system.

Mr. DENTON, replying, said he was entirely in agreement that the Halifax plant was saved a lot of possible trouble by the splendid way in which the plant had been put down. He might say—he had omitted to mention it in the paper—that the gas, instead of going directly into the receivers, was carried along a pipe which had small holes in it, and the gas was sent to the inside of the receiver through these small holes, which undoubtedly assisted largely in the elimination of condensation. He could see the possibility of conditions under which there might be condensation 6 miles from the works. He thought it was probably due to the throttling of the gas. Condensation at Halifax, he might mention, was generally small, on the low-pressure and high-pressure mains alike. With regard to the question of governors leaking, there was never any of that trouble at Halifax.

Mr. J. W. HORWILL (Bradford), Junior Vice-President of the Association, moved a vote of thanks to the Halifax Gas Committee and Mr. McLusky for their hospitality and the facilities afforded to the visitors. The Association fully recognized what a

great friend they had in Mr. McLusky, who had often given them the benefit of his wide experience. The fact that Mr. McLusky's interest in the Association was fully appreciated was evidenced by the large attendances which were always attracted to Halifax. At Halifax there was always something new to be seen and studied. Halifax were making continuous progress, and because of that were always making changes. As the lately retired Hon. Secretary of the Association, he would like to take that opportunity of expressing his personal thanks to the Engineers of the Yorkshire gas undertakings for the ready help and kindness which had been given him in his duties in a secretarial capacity during several years past.

Mr. C. R. INGHAM, Engineer and Manager, Brighouse Gas Department, seconding the vote of thanks, remarked that he had known and esteemed the Halifax Gas Department ever since he had been connected with the industry. The members of the Association came to Halifax time after time, and they always received a homely welcome and saw something of interest. The paper and discussion that day, and the visit to the new vertical plant, had been extremely interesting. He felt more favourably impressed by vertical retorts that day than he had ever felt before. At Halifax they had excellent results. Mr. McLusky was a man of great energy and originality of thought. The system of gas charging which he had instituted there had been a pioneering movement.

Mr. MCLUSKY, responding on behalf of his Committee and himself, said the Halifax Gas Committee were always interested and delighted to know the Yorkshire Juniors were coming. Personally, he enjoyed the Association's gatherings very greatly, and his only regret was that he could not be present more often. When the high-pressure plant was first put in he was not so well supported in its control as he was to-day. He was somewhat of a lonely man then; and it had since been a very great pleasure to see the young men grow up with the plant, and take such a keen and efficient interest in their particular job. If they in Halifax had done anything unusual in the progress of gas, it was because consistent progress was forced upon them in this world of increasingly keen competition, with its growing difficulties. It took a good deal of courage, he admitted, to start something entirely new; but if one tried a few things, one gradually got accustomed to it, and developed boldness. When he had first conceived the Halifax scale of charges, as far back as 1912, it was only accepted after close and prolonged consideration at several meetings. Since it had been put into operation it had proved entirely successful. The public had benefited by it greatly, and it was a delight to see cottage houses using 2000 c.ft. of gas per week, and no coal at all. A working man had expressed his gratitude to him (Mr. McLusky) by remarking how fine it was for his wife to have finished her housework in the morning. Anything the gas industry could do to lessen the burden of the housewife was a great achievement.

The PRESIDENT announced that the next meeting of the Association would be on Feb. 16, at Bradford, when Mr. E. R. B. French, of Leeds, would give a paper on "Some Water Heating Problems."

LONDON AND SOUTHERN DISTRICT JUNIOR GAS ASSOCIATION.

Thermal Insulation of Domestic Hot Water Boilers.

A Meeting of the Association was held at the Westminster Technical Institute, Vincent Square, S.W., 1, on Jan. 25, under the presidency of Mr. W. TREVOR KENSHOLE, of the Lea Bridge District Gas Company.

The PRESIDENT said that, before coming to the business proceedings proper, he had a very interesting announcement to make in connection with one of the premier officials of the Association—one who was a great friend of all the members, and a great worker for the Association. He referred to Mr. Arthur Tennant, their Hon. Secretary, who had been appointed Sales Manager to the East Surrey Gas Company. He (Mr. Kenshole) was expressing the feeling of all present when he wished Mr. Tennant success and prosperity in his new work.

THERMAL INSULATION OF DOMESTIC HOT WATER SUPPLY INSTALLATIONS.

Mr. C. A. Masterman, B.A., A.I.C., who is a member of the Technical Staff at Watson House, Gas Light and Coke Company, then read a paper on this subject. The first part of the paper follows this report.

Discussion.

The PRESIDENT observed that, though—as Mr. Masterman had so clearly demonstrated—the subject of the lecture was of extreme importance, it was one which had certainly not yet received the attention which it merited. On the works, particularly since the war, great efforts had been made to cut-down heat losses; but too little consideration had been paid to reducing the heat losses of consumers' appliances—to combining the greatest efficiency with the maximum economy. And bearing in mind the facts brought out by the author in his paper, it was difficult to understand why this should be the case. There was no doubt that careful study of the paper would be amply repaid.

HEAT LOSSES FROM GAS COOKERS.

Mr. F. S. LARKIN (Gas Light and Coke Company) said that many years ago he had carried out some experimental work relating to the thermal insulation of gas cookers—work, however, which admittedly was not on such a scientific plane as that discussed by the author in his paper. Mr. Masterman had, in the early part of his contribution, suggested that half the heat losses from a gas oven could be accounted for by thermal leakage through the oven walls. This might be true; but he (Mr. Larkin) must point out that, if the cooker was to be reconstructed in such a manner as to overcome this heat loss, then very close attention should be paid to the fitting of the oven door and to the joints generally. He had examined many cookers which had been returned from the district, and consequently was able to appreciate the conditions under which they were called upon to give service. The castings of the cooker were bolted together, and strains were inevitably set up by the alternate heating and cooling which occurred in practice. As a result, it was often the case that the cooker doors were far from being an exact fit. Indeed, he had often stopped-up the flue of one of the cookers brought back from the district, and yet had obtained satisfactory combustion. It had been proposed that the oven door should be swung from the centre and hung from the side. At present, as they were all aware, the door moved on pins at the side; and these pins, due to wear and to the strains set up by expansion, were apt to twist, and consequently to affect the fitting of the door. Mr. Larkin went on to say that another point which interested him was the author's reference to Leroy's insulating composition. He (the speaker) well remembered using this twenty-five years ago; and he was glad that it had maintained its old reputation. On the question of insulating materials, it was interesting to recall that some time ago certain manufacturers suggested that ¼-in. millboard was as effective as 1-in. asbestos. He was glad that this idea was quickly abandoned. Of course, all insulation problems ought to be considered in the light of local circumstances. In some instances the application of insulating material might be beneficial; in others the reverse might be the case. In regard to a domestic boiler, for example, fitted in the kitchen and connected to a radiator in the hall, obviously all the available radiation was needed in the winter, and consequently lagging was not necessarily desirable. In the summer a geyser would be employed for hot water supply; and therefore, in this season, too, there would be no necessity for lagging. Concluding his remarks, Mr. Larkin said that he thoroughly agreed with the author regarding the advantages of abrupt thermostatic control. Mr. Masterman had referred to the new low-consumption gas boiler, which showed up well on thermostatic test. However, there might be a difficulty in getting domestic staffs to accommodate their routine to the working of the boiler.

REDUCING INSULATION TO A MATHEMATICAL BASIS.

Mr. F. C. SMITH (Watson House, Gas Light and Coke Company) remarked that he had had the opportunity of watching the work which the author had carried out at Watson House; and he considered that it was a highly creditable achievement for Mr. Masterman to have investigated this complex problem of thermal insulation, and to have reduced it to a mathematical basis. He (the speaker) had been most interested in the author's observation that, even with high boiler efficiency, every heat unit lost from the water represented nearly one-and-a-half units produced by the burning gas, so that avoidance of this waste was not only technically simple, but was automatically magnified in terms of fuel economy. A few months ago, said Mr. Smith, the question of fuel economy was discussed at the World Power Conference; and the problem was divided into two parts. First, there was the efficient production of the fuel; and secondly there came the utilization of this fuel to the best advantage. In the gas industry, the engineer and the chemist were doing their utmost to produce gas economically; and it was the duty of all on the distribution side to ensure that the economies thus effected were passed on to the consumer. In this respect lagging of appliances was of very great importance. Much of the work undertaken at Watson House had for its object the ensuring that the consumer gained the maximum advantage from the employment of gas. Mr. Smith said that he would like to ask the author two questions. First, could the heat losses from a cooker be reduced by increasing the lagging; and did this necessarily imply the use of a greater thickness of lagging material? To his (the speaker's) mind, some of the loss might be avoided by modification of the cooker castings, with a view to making them more continuous. As things stood at present, there was too great a loss by conduction. Secondly, he would be glad of the author's opinion regarding the future prospects of the low-consumption gas boiler. He (Mr. Smith) had had occasion to inspect several building estates, and he had found that in many cases the sculleries were both small and ill-ventilated. In such circumstances, the advisability of installing a gas wash-copper consuming (say) 40 c.ft. of gas an hour became a matter for serious consideration; and it would be interesting to know

whether Mr. Masterman regarded the low-consumption boiler as a means of overcoming this difficulty.

Mr. C. CLACK (Tottenham District Gas Company) asked whether solid packing would be more advantageous than slag wool for insulating gas ovens. Slag wool was apt to descend to the bottom of the insulating cavity, and thus lose its beneficial effect.

Mr. LARKIN observed that this took place only when the packing of the slag wool was carried out badly in the first instance.

THE AUTHOR'S REPLY.

Mr. MASTERMAN, in a brief reply to the points raised during the discussion, said that his remarks on the heat losses from a gas oven were not to be regarded as specific. The point was that one was apt to think of the flue losses as being inevitable, and somewhat to disregard the fact that much heat was dissipated through the oven walls. However, he had not investigated the problem closely. The low-consumption gas boilers were new, and it was impossible at this juncture to state definitely that they were going to be a tremendous success. Any such prophecy would be dangerous. At the same time, looked at from the viewpoint of theory, they did appear to be just what was wanted. The new equipment undoubtedly gave good service, and overcame the difficulties of fluepipe fixing. It was lagging, concluded Mr. Masterman, which had made this type of boiler possible.

VOTE OF THANKS.

Mr. S. A. CARPENTER (North Middlesex Gas Company) proposed, and Mr. W. R. MOGER (Tottenham District Gas Company) seconded, a vote of thanks to the author for his paper, and Mr. MASTERMAN's reply terminated the meeting.

THERMAL INSULATION (WITH ESPECIAL REFERENCE TO DOMESTIC HOT WATER SUPPLY INSTALLATIONS).

By C. A. MASTERMAN, B.A., A.I.C. (of the Technical Staff of Watson House; Gas Light and Coke Company).

Paper before the London and Southern District Junior Gas Association on Jan. 25.

HEAT LOSSES FROM DOMESTIC APPARATUS.

To any gas consuming apparatus a definite and limited amount of heat is supplied by the burning gas. In very few cases do we receive back the full equivalent of this heat supplied. The difference may be accounted as waste, but this waste is in two forms—(1) Waste during conversion to the form of energy output required; and (2) waste after conversion and before the energy is applied to the purpose in view.

For instance, in a heat-operated refrigerator several heat units must be supplied in practice in order to extract one heat unit from the cabinet, that is, to give one unit of cold. Some wastage in conversion is unavoidable. Any subsequent wastage of the cold produced is therefore doubly wasteful, since the cold has already cost several times its equivalent in the original heat required to produce it. Steps must be, and are, taken to conserve the cold, and refrigerator cabinets are invariably covered with a layer of non-conducting material often several inches thick. The provision of this material is a capital charge which may very soon be written off against the saving in fuel costs; though in the apparatus in question it is even doubtful whether any effective cooling inside the cabinet would take place in the absence of the lagging protection.

Lagging on cooker ovens is now usual, and I had hoped to have available some figures as to its effect. It is significant that results obtained by a colleague of mine suggest that even from a modern lagged oven more than half the heat loss is through the walls. In view of the thickness of lagging normally used, and the general oven construction, this result is not altogether surprising, and it points the way to a potential improvement in design. A reduction in this loss, besides diminishing the gas maintenance rate of the oven, possesses the advantage of lessening the excessive and uncomfortable heating-up of the small kitchen or scullery in which the cooker is now often to be found.

The connection in which I want more particularly to go into the pros and cons of thermal insulation is with domestic hot water supply installations. Lagging on these is comparatively rarely used, even when long lengths of exposed flow and return pipe are reducing the efficiency to a very low figure. Some considerable care is taken in boiler design to ensure extraction of the maximum amount of heat from the burning gas, but the extracted heat is thereafter allowed to escape freely from the water to the room. Even with high boiler efficiency every heat unit lost from the water represents nearly one-and-a-half units produced by the burning gas, so that avoidance of this source of waste is not only technically simple, but is automatically magnified in terms of fuel economy. It may be suggested that this heat loss serves a useful purpose in also warming the house, but, like most double purpose tools, the two requirements are not coincident. In winter the desire for room comfort may lead to running of the hot water installation when no hot water is required, while house warming in summer whenever hot water is desired may often be unseasonable.

Fig. 5 shows roughly the progress of the warming effect of certain lagged and unlagged installations after the gas is turned out, the total initial heat contents in the water being the same in both cases. If boiler efficiency tests are carried out, the increase due to lagging may be found to be not more than 10 p.ct., but on household usage certain other factors may increase this contrast very considerably. Prolonged trials have been carried out to determine the effect of lagging in practice, and to arrive, if possible, at a simple expression by which the saving to be obtained thereby may be forecast with approximate accuracy.

NATURE AND PREVENTION OF HEAT LOSSES.

A brief review of the mechanism of heat loss is of help in considering the means for preventing it.

From an exposed hot surface heat loss occurs in two ways. First, heat is conducted from the surface to the air in contact with it. Air has a low conductivity, and this loss would be proportionately small if the air remained stationary. In practice, even if the air is initially still, as soon as it is warmed by the hot surface it rises, drawing cold air into contact with the surface, and so the heat loss continues at a comparatively fast rate. Secondly, heat loss takes place by radiation to the surroundings in all directions, the rate depending upon the temperature of the surface and of its surroundings, and upon the nature of the surface.

Superficial heat loss may, therefore, be reduced in two ways —by reducing the loss to the air, and the loss by radiation.

In connection with the liquefaction of gases, where extreme cold is required, and heat transfer must be reduced to a minimum, Dewar dealt with this two-fold problem, and produced the familiar vacuum flask. For the liquefied gas he used a double-walled vessel, and heat transfer between the inner vessel and the air surrounding it was reduced by removing the air. Heat transfer was thereby reduced to about one-fifth. Radiation was diminished by the use of silvered surfaces which reflected the radiant heat which would otherwise have passed into the inner vessel. This second step reduced the rate of heat transfer to about one-sixth of that in the plain vacuum vessel. By this double precaution a serious difficulty in the investigations was overcome, the total heat transfer being reduced to about one-thirtieth of its original figure.

Clearly we cannot economically use vacua or silvered mirrors on domestic boilers, but practicable substitutes having the same characteristics are available. For the lagging a non-conductor is required, and the materials in this class are familiar. Almost invariably they are fibrous or cellular in structure, and rely for their insulating properties upon the large amount of air anchored in their substance. It is the fact that this air is maintained in a stationary condition which renders these materials useful for our purpose. If allowed to become wet a large increase in conductivity is observed, while by special drying a lower conductivity than normal may usually be obtained. The application of a layer of such lagging obviously reduces the heat losses by radiation very considerably, owing to the lowered temperature of the exposed surface. If, however, this exposed surface remains, owing to inadequate lagging, at a temperature appreciably above room temperature, the losses may be further diminished by giving the surface a finish of low emissivity. This will correspond to Dewar's silver mirrors, high reflection and low emission being associated qualities. As an example of the appreciable effect produced, it is found that the total heat emission from bare cast-iron steam radiators under normal conditions may be reduced by over 15 p.ct. by the use of aluminium paint. The application of such a coating to the outside of a porous lagging has the additional advantage of reducing the porosity, and hence the associated heat losses to the air.

THEORETICAL CONSIDERATIONS.

When a low emissivity finish is applied to a layer of lagging the surface losses are less, and the surface temperature rises. The temperature gradient through the lagging is less steep, and the heat transfer is reduced. In equilibrium the heat transfer through the lagging must equal the heat loss from the surface. Hence may be derived a quantitative expression for the rate of heat loss from thermally insulated surfaces. By combining the conductivity formula

$$Q = \frac{KAT\,(t_2 - t_1)}{d} \quad \ldots\ldots\ldots (1)$$

and Newton's Cooling Equation (assuming the inaccuracies in applying it over this temperature range are not great)

$$Q = NAT\,(t_1 - t) \quad \ldots\ldots\ldots (2)$$

it is simple to eliminate the unknown t_1.

Where Q = Quantity of heat conducted through the lagging.
= Quantity of heat lost from the surface of the lagging.
K = Coefficient of conductivity.
A = Area of surface.
T = Time.
d = Thickness of lagging.
t_2 = Temperature of inner surface of lagging.
t_1 = Temperature of outer surface of lagging.
t = Temperature of room.
N = Heat loss per unit area in unit time per degree difference in temperature between exposed surface and room. (This includes loss by conduction to the air and by radiation to the room.)

From (1) $t_1 = \frac{KAT\,t_2 - dQ}{KAT}$

From (2) $t_1 = \frac{Q - NTA\,t}{NTA}$

Hence $\frac{KAT\,t_2 - dQ}{KAT} = \frac{Q - NTA\,t}{NTA}$

$$Q = \frac{NKAT\,(t_2 - t)}{Nd - K}$$

Heat loses will, therefore, vary directly with surface area, with time, and with temperature difference between inner surface of lagging and room.

When lagging thickness is great, losses will vary approximately as co-efficient of conductivity, but with a very thin layer of insulation, the surface condition N of the lagging may be the more important factor.

The influence of increase in lagging thickness on heat loss is greatest when the thickness itself is least. The type of relation found in practice is shown in fig. 1.

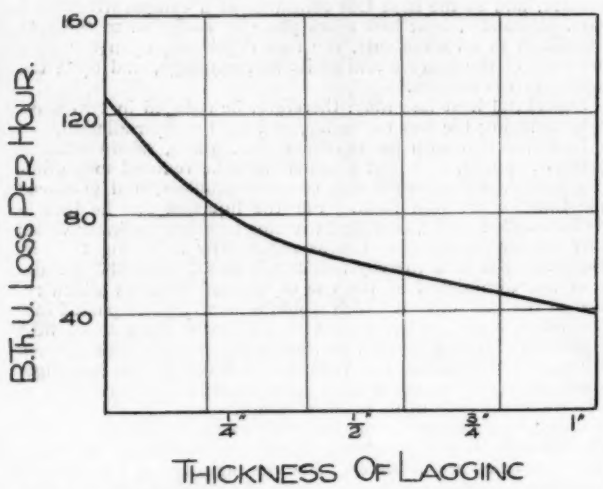


Fig. 1.—Types of Relationship Between Heat Loss and Lagging Thickness.

The following reasons why the above expression is not strictly accurate nor immediately helpful for domestic installations deserve mention.

(*a*) The lagging material used is usually not homogeneous, and the conductivity K and superficial cooling "constant" N are not standardized nor even stable qualities.

(*b*) The inner surface of the lagging will often not be at the same temperature as the tank or pipe to which it is applied. (It may sometimes be desirable to emphasize this temperature difference by giving the metal surface a low emissivity finish before application of the lagging.)

(*c*) The temperature t_2 of the tank, &c., will not remain constant, but will usually be higher after the application of insulation.

(*d*) The cooling equation will not accurately apply over the temperature ranges existing, and will be modified by the presence of draughts and the fact that some surfaces are vertical, others horizontal, &c.

(*e*) The application of lagging to domestic apparatus or pipe lines will invariably increase the surface area exposed, and so diminish the advantage obtained. Table I. shows the effect of 1 in. thick layer of lagging on the surface area in square feet, with various geometrical shapes and sizes of tanks, and it is seen to be large, especially for such sizes as will be in domestic use.

Partly on this account the rate of heat loss will be found in this connection to vary roughly in inverse proportion to the square root of lagging thickness (*cf.* fig. 3).

(*f*) The ratio of surface area to capacity has an important bearing upon the proportionate heat losses. Fig. 2 shows this ratio for cubical tanks of different capacity and for pipes of different diameter. The proportionately high heat loss to be expected with the small tanks and pipes in domestic use is evident. The influence of shape upon this ratio may be inferred from Table I.

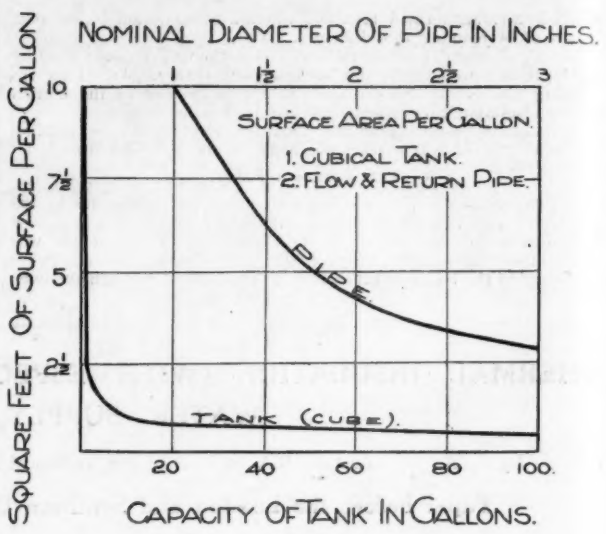


Fig. 2.

Table I.

Size of Tank.	Shape of Tank.	Initial Surface Area.	Final Surface Area.	Increase. P.Ct.
6 gall.	Sphere	4·8	6·2	29
6 ,,	Cylinder 6 in. high	6·3	8·3	31
6 ,,	,, 1 ft. ,,	5·4	7·2	33
6 ,,	,, 4 ft. ,,	7·4	10·2	38
6 ,,	Rect. box 6 in. ,,	6·6	9·0	35
6 ,,	Cube 1 ft. ,,	5·8	8·0	38
6 ,,	Rect. box 4 ft. ,,	8·3	11·8	42
48 ,,	Cube	23·0	27·0	17
162 ,,	,,	52·0	58·0	12
10 ft. long, 1 in. pipe.	..	2·5	8·0	220
10 ,, ,, 3 in. pipe.	..	8·0	12·5	56

(*g*) The amount of water drawn off, the frequency with which it is drawn off, the temperature at which it is drawn, the temperature of the room, the length of time which the gas is alight, &c., will vary greatly in different households. The effect of these conditions of usage upon the heat losses from the installation is great.

Choice of Materials.

As a preliminary to describing in detail the experimental results of trials designed to provide the information required, a review of the merits of various lagging materials is desirable. The requirements for domestic use will necessarily be searching, and no known material fulfils all the conditions perfectly. The following qualities must be taken into account:

(*a*) Thermal insulating properties.
(*b*) Thermal capacity (should be low in view of intermittent type of usage).
(*c*) Resistance to repeated heating and cooling for temperature range from about 40° Fahr. to 160° Fahr. (If near flue pipe a higher maximum temperature may be reached.)
(*d*) Mechanical strength.
(*e*) Resistance to corrosion or insect attack.
(*f*) Sanitary and without smell.
(*g*) Easy, clean, and quick to apply. (If applied during manufacture this is of less importance.)
(*h*) Suitable for application to curved or irregular surfaces.
(*j*) Easy removal for boiler cleaning, repairs, or during cold weather, when heat from set is required to warm the surroundings.
(*k*) Reasonably fire resistant.
(*l*) Cost, and alternative sources of supply.

The familiar lagging materials fall into four classes:

(1) Cements (*e.g.*, Leroy). Probably the commonest form of material used for lagging. The proper application is specialized work, and usually two visits to the premises

will be required in order that drying may take place before the finish is applied.

(2) Rigid Lagging (*e.g.*, cork composition, cellular asbestos). Except for the simplest shapes this will require special manufacture.

(3) Flexible Lagging (*e.g.*, felt). In general this will require an external wrapper to hold it in position. The question of insect attack or harbourage requires special attention.

(4) Granular or Fibrous Material (*e.g.*, cork chips, cotton wool). An external rigid jacket is essential.

The choice of material will necessarily depend upon whether the lagging is to be applied during manufacture, or is for the protection of existing installations. The latter represents the more difficult type of case, and attention has been concentrated upon it.

(To be continued.)

MACHINE FOR QUICK REPAIRS TO ROADS NECESSITATED BY DAMAGE TO MAINS.

The recent succession of explosions and fractures, in which gas, water, electricity, and other public utility services have been involved, has of necessity brought into prominence the need for the provision of reliable emergency appliances for quick repair work.

Among these has been recently successfully introduced an ingenious combined motor car and air-compressor, which travels to the job at a speed of 30 miles per hour, and on arrival can start operating in the course of a few moments.

Its purpose is to supply compressed air for actuating the power-hammers and other pneumatic tools which are now commonly employed for breaking-up roads and footpaths when laying new mains and service-pipes; or when breaking up the superimposed material, in order to get at the damaged mains and pipes for repairs.

On reference to the accompanying illustrations, it will be seen that the front of the vehicle resembles the familiar motor car. The chassis is of the high-power standard commercial type, fitted with four-wheel brakes, strong springs and axles, pneumatic tyres, and driver's cab. It is equipped with a four-cylinder engine fitted with cooling fan, water-pump, coil and battery ignition, and electric starter.

The air-compressor, which is located over the rear axle, is of the latest Lacy-Hulbert pattern fitted with ball and roller bearings throughout, and with an efficient air filter and silencer; thus reducing the noise to a minimum, and protecting the interior parts from road dust. Special attention has been given to the provision of adequate and economic automatic lubrication.

For use when the chassis is at rest at a job, and the car engine is then driving the air-compressor, an auxiliary radiator and fan are employed. The air reservoir is riveted throughout, and fitted with a manhole. There is the usual pressure-gauge, safety valve, and drain cock. An outlet air-cock is fitted in a suitable position for coupling the hosepipe for connecting to the power-hammers, &c.

The driving of the compressor is effected through a special shaft, running in roller-bearings, by means of clutch-gears arranged to be driven from the flywheel. There are means for

Fig. 1.—Machine with Cover of Air Compressor at Rear Removed.

throwing this gearing in and out, when required, from the driver's seat; the change-over being very quickly effected. The ordinary driving mechanism of the chassis is not interfered with in any way, and is of the standard type. The car can be driven at any speed, and will easily negotiate any hill which is within the hill-climbing capacity of the average commercial motor.

With the compressor working at its full output, it is capable of delivering air at any pressure up to 120 lbs. per sq. in., for working one large concrete-breaker, one road pick, one or two small picks, one or two pneumatic spades, or other tools. The compressor can, of course, be utilized for operating riveting hammers, drilling machines, lead caulkers, road-tampers, paint sprays, and other tools or apparatus pneumatically operated.

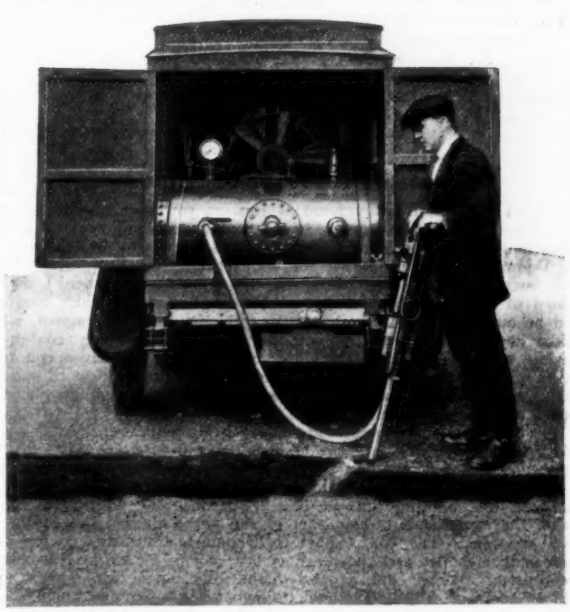


Fig. 2.—Air Compressor in Operation Breaking Up Road.

Its application to a number of purposes in a gas-works and on the district will be obvious.

When called out, the vehicle usually carries a driver (preferably a mainlayer) and his mate; one large concrete-breaker; a 30-ft. length of hosepipe; spare chisels; sundry tools; lamps; &c.

It may be added that one of these cars is being supplied to the order of a large Corporation in the Midlands; and others have the question of its adoption now under consideration.

Ewart & Son, Ltd., Annual Report.—The following is the Directors' report submitted to the shareholders at the twenty-eighth Annual General Meeting held at the Auctioneers' and Estate Agents' Institute, Lincoln's Inn Fields, London, W.C. 2, on Wednesday, Jan. 30. The Directors submit the balance-sheet and the profit and loss account for the year ended Oct. 31, 1928, and report that, notwithstanding the general adverse conditions and the many difficulties that have had to be faced in the past year, the trading of the Company has been well maintained, and the profit earned amounted to £50,847. The Directors recommend that dividends be paid at the same rates as last year, and that the balance then remaining (£2193) be added to the carry forward, which will then exceed the amount required for a full year's dividend upon the preference shares by the sum of £4640. The Company's factories and plant have been maintained in a high state of efficiency, and the high quality of their manufacture retains the reputation gained since the establishment of the firm in 1834. The net profit for the year 1928 amounts to £50,847, to which falls to be added the amount brought forward from last year, namely, £18,558, making a total of £69,405. The dividends on the 16 p.ct. cumulative preference shares paid, less income-tax, in June and December, 1928, absorbed £16,112, and the interim dividend on the ordinary shares of 16 p.ct. paid, less income-tax, on June 30, 1928, absorbed £12,699, leaving a balance of £40,594. The Directors recommend that this balance be dealt with as follows: In payment of a final dividend of 25 p.ct. on the ordinary shares payable, less income-tax, on March 1, 1929 (making with the interim dividend of 16 p.ct. already paid 41 p.ct. for the year), amounting to a total of £19,842, leaving the sum of £20,752 to be carried forward to next year's accounts.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Institution of Gas Engineers—Education Scheme Examinations, 1929—External Students.

SIR,—May I, through the medium of your paper, remind all those proposing to sit for this year's examinations as external candidates that their application must reach me on or before Feb. 28? The appropriate forms may be obtained from the undersigned.

Applications to sit for the examination for the Diploma in Gas Engineering and Gas Supply must also be received by Feb. 28, and the theses in connection therewith must be sent in by the last day of March, at latest.

All candidates who have been approved for the City and Guilds of London Institute examinations in Gas-Works Practice and Gas Supply Practice as external students should apply for accommodation for the examination to the authorities of their nearest technical school.

WALTER HOLE, Organizing Secretary.

Cliff Haven,
Redclyffe Park,
St. Marychurch,
Torquay,
Jan. 28, 1929.

Co-Operative Control of Coal Purchases.

SIR,—I see that in your issue of Jan. 23 you give prominence to the Pittsburgh paper by my friend and fellow-countryman, Prof. Raaschou, on co-operative control of coal purchases by gas-works in Denmark. I had known for some time that Prof. Raaschou was busy organizing something on these lines; and when I mentioned to him that the idea deserved to be known in wider circles, and he ought to go to Pittsburgh to talk about it, he laughed, and asked how I thought that would be received in the big coal-producing countries, and, furthermore, how could he, from a country which did not produce an ounce of black coal, bring forward something which would never be listened to. I told him to go ahead; and I am glad he did.

The British coal exporters naturally, in the beginning, looked with misgiving on the idea that the Danish gas-works in any little township should insist upon coal being delivered to a specification; and it took them some time to realize fully the importance of delivering the best, and nothing but the best. But once the position became clear, they carried out their part of the bargain; and the result is now apparent. The coal export to Denmark from this country is increasing steadily, and the markets lost during the strike are being recaptured. British coal, properly handled, cleaned, and washed, is still unique, and will always hold its own against German and Polish coal on the same basis of purity. In other words, what seemed at first to be a trouble has turned out to be a blessing in disguise for the coal industry. Why not go one step further, and follow the lead over here? Only good can come of it. The collieries must produce clean coal, more coal will automatically be raised, more men will be employed, cleaning plant will be compulsory—more employment—vast sums in profit will be saved on carting dirt, ashes, and moisture up and down the country, a larger gas yield ton for ton is assured in the same size plant, and a superior and cleaner coke is made available. Gradually it will be brought about that the dirt heaps will be left at the pits, where they belong; and we shall all be better off.

The Institution of Gas Engineers is a strong body, and should be able to force its decisons through any obstacles—which, in my opinion, will only be raised by old-fashioned, ill-equipped, and inefficiently-run mines. Why should not the Institution form a committee or sub-committee on "Standards," and approach somebody like Prof. Bone or Prof. Cobb to work out the simplified analytical parts on similar lines to those employed by Prof. Raaschou, who, I am sure, would be willing to let us benefit from his practical experience of working on co-operative control principles? I feel that, by forming a body of directly interested parties, we shall far sooner get to grips with the problem than by waiting for help from any official institution. The collieries with vision will soon co-operate, and the others will, of necessity, be forced to follow. The 20 million tons or more of coal consumed annually by the gas-works in this country is a powerful lever for good; and even if the coal should cost a little more, the gas companies, through their unique position in the economic life, can pass on the cost. I do not say they will do so, but I for one will not object to paying an indirect tax, which in any case can amount only to a few shillings annually as far as my household is concerned, to help the basic industry. I feel I shall recover the money in other directions.

HARALD NIELSEN.

73, Hayes Road, Bromley, Kent,
Jan. 25, 1929.

Metropolitan Gas Company of Melbourne.—Messrs. John Terry & Co. have received a telegram from their Principals, the Metropolitan Gas Company of Melbourne, informing them that the net profits for the six months to Dec. 31, 1928, were £121,450. A dividend of 7s. 6d. per share has been declared; an amount of £25,560 has been transferred to reserve account; and a sum of £61,250 has been carried forward. Dividends will be payable in Melbourne probably on Feb. 1, and those to absentee shareholders will be posted by an early mail.

PARLIAMENTARY INTELLIGENCE.

[From Our Special Correspondents.]

National Fuel and Power Report.

Copies of the Second Report of the National Fuel and Power Committee were formally presented to both Houses of Parliament on their resumption after the Christmas Recess. No opportunity has yet arisen for debate on the Committee's recommendations with regard to the future organization of the gas industry.

HOUSE OF COMMONS.

Private Bills Introduced.

The following Private Bills dealing with gas undertakings were formally presented to the House of Commons on Friday, Jan. 25, and read a first time: Gas Light and Coke Company; Newcastle-upon-Tyne and Gateshead Gas Company; Southport Corporation; South Suburban Gas Company; and Winchester Water and Gas Company.

The following Bills are being first introduced in the House of Lords: Aldershot Gas, Water, and District Lighting; Romford Gas; Sheffield Gas (Consolidation); Wandsworth, Wimbledon, and Epsom District Gas; and Yorktown (Camberley) and District Gas and Electricity Company.

Gas Special Orders.

Plans have been deposited under section 10 of the Gas Regulation Act, 1920, in respect of the following Special Orders: East Hull; Horsham; and Watford and St. Albans.

Gas Legislation.

Mr. A. V. ALEXANDER, Co-Operative M.P. for Hillsborough (Sheffield), asked on Monday whether the Government intended to introduce a Bill this session to amend the legislation governing gas undertakings; if so, at what date the Bill would be introduced, and what was its main purpose.

Mr. H. G. WILLIAMS, Parliamentary Secretary to the Board of Trade, stated that a Bill was now being drafted, and that it would shortly be introduced in another place. He was not able to indicate its terms in answer to a question.

[From reliable sources, it is understood that the Bill, which will be on modest lines, and non-controversial, will be introduced in the House of Lords this week or next.]

Recent Gas Explosions.

Questions were put down for answer on Tuesday by Mr. HORE-BELISHA and Sir HARRY BRITTAIN, asking the Minister of Transport to hold an inquiry into the causes of recent underground explosions in London, with reference to the effect on underground services of modern traffic weights and speeds.

Amalgamation of Coking Plants.

Lord HENRY CAVENDISH-BENTINCK is to ask the Prime Minister to-day whether the Government will consider what assistance and encouragement it can give towards the amalgamation of the coking interests in Durham and Northumberland, in order that the present number of coking plants may be largely reduced, and inefficient plants replaced.

REGISTER OF PATENTS.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Jan. 9.]

Nos. 1—502.

BOTT, T. L.—"Pressure equalizer for gasholders." No. 51.

SULZER FRERES SOC. ANON.—"Containers for dry cooling hot coke." No. 63.

[Extracted from the "Official Journal" for Jan. 16.]

Nos. 503—1201.

BAUMANN, C.—"Driving means for gas compressors." No. 1044.
BERGFELD, K.—"Gas pressure regulators." No. 1123.
COCKEY & SONS, LTD., E.—"Valves for gas purifiers." No. 932.
HEARSON, J. W.—"Gas scrubbers." No. 1114.
METERS, LTD.—"Gas meters." No. 1142.
STANSFIELD, A.—See Meters, Ltd. No. 1142.
STOVES, LTD.—"Gas boiling devices." No. 658.

[Extracted from the "Official Journal" for Jan. 23.]

Nos. 1202—1950.

BAMAG-MEGUIN AKT.-GES.—"Plant for production of water gas." No. 1264.
BROWN, G.—"Ventilators for gas mains." No. 1792.
BUXTON, R. H.—"Means for regulating calorific value of gas." No. 1420.
CLARK, J. G.—"Thermostatic devices for regulating temperature." No. 1338.
CROFT, C. M.—See Buxton, R. H. No. 1420.
GAS LIGHT AND COKE COMPANY.—See Clark, J. G. No. 1338.
GEWERKSCHAFT M. STINNES.—"Process for purification of coal distillation gas." No. 1308.
HELLER, O.—See Bamag-Meguin Akt.-Ges. No. 1264.
HUFF, W. J.—"Purification of gas." No. 1934.
LOGAN, L.—See Huff, W. J. No. 1934.
LUSBY, O. W.—See Huff, W. J. No. 1934.
WESTWOOD, W. W. SKIDMORE.—"Detection of leaks in gas mains." No. 1365.
ZWILLING, L.—"Electric gas lighters." No. 1564.

MISCELLANEOUS NEWS.

ALDERSHOT GAS, WATER, AND DISTRICT LIGHTING COMPANY.

Address of the Chairman and Managing Director, Mr. R. W. Edwards, at to-day's Annual Meeting.

The Annual Meeting of the Aldershot Gas, Water, and District Lighting Company was held to-day (Wednesday)—Mr. R. W. EDWARDS, Chairman and Managing Director, presiding.

The formal business of opening and the confirmation of minutes having been taken, the CHAIRMAN said:

GAS.

The beautiful summer, followed by a comparatively mild autumn, was undoubtedly appreciated to the fullest by the general public, for it permitted a greater indulgence of pleasure in the open air. In support of these remarks, it is interesting to note the total hours of sunshine for 1928—viz., 1745·82—as compared with 1927—1456·35—and in conjunction with these statistics we should realize how rare such an abundance of sunshine is, for we have to go back to 1921 for a comparative figure, when the total sunshine for that year was 1795·8.

Further, without wearying you, I would like to quote the average monthly maximum temperatures for the latter six months of the years 1921, 1927, and 1928.

—	1921.	1927.	1928.
	° Fahr.	° Fahr.	° Fahr.
July	80·1	68·0	75·4
August	71·8	68·9	69·8
September	70·7	62·4	67·0
October	67·2	58·4	59·0
November	45·8	47·8	51·9
December	48·4	38·9	42·7

Period between 7 a.m. and 6 p.m. G.M.T.

What does strike one as notable for 1928 is the high maximum temperature for the month of November, which was 51·9° Fahr., as against 47·8° Fahr. for November, 1927. The nearest approach to 1928 during the past ten years was November, 1920, with 50·2° Fahr.

While we of the gas industry rejoice, as members of the community, when such enjoyable weather favours us, we cannot help but be conscious that it is not conducive to the fuller use of installed gas apparatus; and, therefore, we may reasonably suggest that the year 1928 was not an ideal gas sales year. Notwithstanding this, we derive some measure of comfort from the fact that when good weather encourages us to go into the open air, it also brings a full appreciation of the advantages in having a service of heat, &c., immediately responsive to the touch of a tap on our return home tired.

After allowing for these circumstances, the increase in our gas sales has been somewhat retarded by the termination of a very old War Department bulk contract, which expired at the end of February last. Fortunately, this was anticipated; and a more comprehensive agreement has been entered into which provides for supplying the Secretary of State for War with gas for use in official buildings throughout that part of the Aldershot Command within this Company's statutory limits of supply.

Excluding the effect of the termination of the old contract referred to, the sales of gas to all other consumers and public authorities represented an increase of 3·6 p.ct.; but including the effect of the War Department bulk contract, 1·7 p.ct.

The price of gas has been reduced since the end of the general strike in 1926 by 2·6d. per therm, representing 1s. 1·65d. per 1000 c.ft. These reductions include 0·6d. per therm (3·15d. per 1000 c.ft.) from the readings of the meter for the Christmas quarter. It is hoped to make further reductions in the price at midsummer.

The apparatus added for the year, as compared with 1927, was as follows:

—	1927.	1928.
Cookers	537	567
Fires	768	837
Hot water	474	333

The amount received for residuals represented 53·5 p.ct. of the cost of coal, as compared with 56·6 p.ct. in 1927.

The yield of liquid products, calculating for ammoniacal liquor of 8 oz. strength, was 45·7 gallons, as compared with 43·7 gallons for 1927, per ton of coal carbonized.

WATER.

The progress of this department has been quite good. The maximum net domestic consumption per head of the population in any one day during the year was 27·6 gallons, as against 34·8 gallons in 1927, and, over the same period, the average net domestic consumption per head of the population was 15·26 gallons, as compared with 15·79 gallons for 1927. Again I have to pay tribute to the excellent work of our water inspectors.

The rainfall for the year was 29·17 in., as compared with 37·34 in. in 1927—the latter being the wettest year but one (1903) over 100 years.

As is our policy, our works and plant have been maintained in a good state of efficiency, and certain repairs have been executed at one of our pumping stations, which has increased our expenses.

ELECTRICITY.

This department shows an increase in sales in our "B" Area, during 1928, of 18·1 p.ct., as compared with 19·6 p.ct. in 1927.

The following apparatus has been added during the years 1927-28:

—	1927.	1928.
Lamps	3554	4434
Motors	9	15
Fires	50	75
Cooking	14	18
Sweepers	34	42
Irons	23	33
Miscellaneous	17	38

The year 1928 shows an increase in every item over the previous year.

The financial results of the Hindhead undertaking, absorbed by this Company on Dec. 20, 1928, are not yet complete, but a full statement of the assets and liabilities will appear in the 1929 accounts.

Three additional Special Orders have been deposited, and a public inquiry was held by the Electricity Commissioners on Jan. 15, 16, and 17, the result of which is not yet available.

The price of electricity, for lighting purposes, has been reduced since Michaelmas, 1927, by $\frac{1}{8}$d. per unit, which includes 0·3d. per unit operative from the last quarter day's meter readings, and for all other purposes, from midsummer, 1927, 1$\frac{3}{8}$d. per unit, which includes $\frac{1}{8}$d. per unit operative also from the readings of the meters for Christmas last. It is hoped to make further reductions from midsummer; and again such reductions will be applicable to our added areas.

CAPITAL.

For the three undertakings, including Hindhead, the amount of capital authorized is £1,206,367 14s. 2d. Of this, there has been received £809,690 12s. 5d. Adding a debit balance of £74,114 4s. 6d., we arrive at a total of £883,804 16s. 11d., from which £40,989 8s. 3d. (added on consolidation in 1909) is deducted to arrive at a net figure of £842,815 8s. 8d.

After deducting appreciations, £15,171 7s. 1d., there was a credit on capital account for the year of £7353 7s. 2d.

The net capital expenditure during the year was £7817 19s. 11d.—principally on electricity.

GENERAL.

We have added a total number of consumers for the year (including Hindhead) of 2513—making a total increase of 7453 in five years. It is hoped to make a commencement with the erection of new showrooms at Fleet and Hindhead during the year.

The Directors pay full tribute to the three principal Officers—the Chief Engineer, the Secretary, and the Chief Accountant—and to all officials and employees in their respective departments, for the devotion and zeal which has been given to the Company in the execution of their duties.

The co-partnership scheme is very much appreciated, and the bonus for the year ended June 30, 1928, was at the average rate of 6·8 p.ct. The Sports Club and Benevolent Funds, in collaboration with Convalescent Homes, have done good work during the year, respectively for the recreation of the various employees and for the relief of those who have been ill or injured.

I now move the following resolution:

> That the Directors' report with the statement of accounts for the twelve months ended Dec. 31, 1928, be and are hereby adopted, and that the dividends as therein recommended be and are hereby declared to be forthwith payable to the proprietors.

The resolution was seconded by the DEPUTY CHAIRMAN (Mr. Thomas A. Braddock), and carried unanimously.

Mr. C. P. Crookenden, F.C.A., was reappointed a Director of the Company, and Mr. Lionel Maltby, F.C.A. (of Messrs. Deloitte, Plender, Griffiths, & Co.), was re-elected an Auditor.

The proceedings closed with a vote of thanks to the Chairman, Directors, and staff.

THE BLOOMSBURY EXPLOSION.

Resumed Inquiry.

The Inquiry was continued on Tuesday, Jan. 22. [The proceedings on Monday, Jan. 21, were reported in the "JOURNAL" for Jan. 23, p. 229.]

In accordance with the arrangement made, evidence was first heard with regard to the gas leakage at 216, Shaftesbury Avenue.

It appeared that a high-pressure street lighting maintenance fitter in the employ of the Gas Light and Coke Company was passing 216, Shaftesbury Avenue, in the course of his patrol at about 7.30 p.m. on Dec. 16, when he noticed a strong smell of gas coming from a broken pavement light. The police were sent for, and also the caretaker. Word was also sent to the Gas Company; and the service layers came after a fitter had found, by turning off the gas at the meter and capping the service pipe, that the leak was outside the premises. When the service layers arrived, they opened the road and found a 4-in. main fractured all round. This was temporarily stopped in the usual way. The report on the work also stated that a 1-in. service pipe was decayed, and temporarily stopped; but the evidence was that the pipe was not actually perforated. The crack in the 4-in. main was stated to be sufficient to insert the edge of the blade of a penknife. It was also stated during this evidence that the pavement at this spot had sunk in places, and generally wanted levelling-up, over the 4-in. main.

The CHAIRMAN put questions as to the gas leaking into the cellar from the 4-in. main.

The witnesses who dealt with this matter said that the service pipe from the main was properly built into the brick wall, and there was no means—except by percolation through the brickwork and soil—for the gas to enter the cellar from the leaky main, otherwise than through the service pipe. On further examination the following day, it was found that the service pipe was in good condition; and to that extent the reference in the first report as to the service pipe being decayed was admitted to be an error. The service pipe was still in use.

The service layer said that the fracture of the pipe was complete, and the main came apart when all the earth was removed. He added that the fracture was a recent one, judging by the appearance of the metal at the fracture. The soil was maiden soil, and there was no sign of a subsidence or hollow under the main; and witness was unable to give any reason for the fracture occurring.

INSPECTION OF POST OFFICE MANHOLES.

William Rogers, trench examiner in the employ of the Gas Light and Coke Company, said that regularly every alternate day from April, 1928, to Dec. 18, 1928, he had examined the manholes on the Post Office subway, to test for the presence of coal gas with a gas detector; but he had failed to detect coal gas. He had done this work under special instructions.

The ATTORNEY-GENERAL put questions suggesting that tests carried out during December at certain of the manholes showed coal gas to the extent of 5 p.ct. and 7 p.ct., and added that evidence would be given regarding this.

Witness said that on Dec. 18, at the Central Post Office manhole, he got an indication of 4 on his instrument; but as the indicator jumped back again immediately, he knew it was not coal gas. If it had been coal gas, the indicator would have taken three times as long to go back as it did to make the indication. He therefore assumed it could not be due to coal gas, though he notified his foreman of what had happened.

The ATTORNEY-GENERAL questioned witness somewhat severely as to why this occurrence did not appear in the Ground Complaint Book.

Answering Mr. MILLER,

Witness said he had obtained the same kind of indication at this particular manhole since last July. The smell was more like that of cut wet grass which had been left out to rot. He added that on one occasion he had been into the Post Office tube, and the smell there was of the same nature as, but stronger than, the smell he got at the manholes when testing.

Mr. *Whalley*, mains and service foreman, who has been in the Gas Company's service for 25 years, spoke of tests for gas carried out in September last at the keyholes of Post Office tube manholes, in company with Mr. Sinclair of the Post Office. No indication of gas was found, but Mr. Sinclair desired further information, because there was a jerky movement of the needle, as mentioned by the last witness, though the instrument used was of a different type. He attributed the jerky movement to hot air coming up from the subway. If coal gas was present, the needle would move forward steadily, and would remain at the indication. He said that the last occasion on which gas was found in the tube was in April, 1928, and added that, though the Ground Report Book referred to slight indications later on, he always erred on the right side, and reported the presence of gas even if there was a doubt; and the matter was further investigated.

Mr. TREVOR WATSON, for the London County Council, put it that ever since April last year Rogers and Whalley had been testing the Post Office tube, and getting the jerky movement at the instrument without knowing whether or not it was caused by coal gas.

Witness said he would have smelt it if it had been coal gas.

This completed the general evidence so far as the Gas Light and Coke Company were concerned, and Mr. MILLER addressed the Commissioners prior to calling his expert witnesses.

MR. MILLER'S ADDRESS.

Mr. Miller, after reminding the Commissioners that under the Home Secretary's Warrant appointing them they were charged with two duties—(1) to endeavour to ascertain the cause of the explosion and fires, and (2) to make any recommendations they might think fit to prevent a recurrence—said that his remarks at this stage would be primarily addressed to the first portion of the Warrant. At the same time, with regard to the second part of the reference to the Commissioners, the Gas Light and Coke Company had material to offer, and were ready to assist the Tribunal in making any recommendations they might feel in the position to make. Though it was not possible to ignore the question that would ultimately have to be settled—viz., who was liable in this matter—there was no direct reference upon this to the Commissioners; and it was not for the Tribunal to endeavour to clear up the interesting questions which might have to be settled hereafter between the Post Office and the Gas Company in relation to questions of law. If, however, the Commissioners felt able, after full consideration of all the evidence and information placed before them, to point clearly to the absence of reasonable care on the part of any or all of the parties interested in this matter, he had no doubt the Commissioners would feel it their duty so to find. He desired to address the Commissioners on the questions of the facts so far as they had been able to be ascertained, and to suggest strongly that the effective cause of this explosion was the conduct of the Post Office in relation to the old parcels tube. There were necessarily a number of subsidiary matters which arose in this connection, some of which, he contended, were indisputable, though as regards others there might still be some controversy.

For the purpose of his present argument, therefore, he would place before the Commissioners the following six propositions, most of which, he claimed, were proved by the evidence already given. The others would, he believed, be proved by the scientific expert evidence yet to come.

(1) The original explosion occurred in the Post Office tube, and not elsewhere. He doubted whether his learned friend the Attorney-General would find himself able seriously to contest this; and he felt certain that the Commissioners, with their knowledge of the occurrence, must have formed a similar opinion.
(2) The explosion originated at the West Central District Post Office manhole in consequence of something done by a Post Office worker.
(3) The explosive mixture in the tube was probably not coal gas.

It was not his desire, added Mr. Miller, to put the facts too high; and therefore he would go no farther than this. Whether or not there was some trace of coal gas in the mixture, or whether the Attorney-General's attack on the Gas Company's witnesses was warranted, he would not discuss.

The ATTORNEY-GENERAL: I am not conscious of having attacked anybody; and I have not had the opportunity of attacking the chief one.

Mr. MILLER: Who is that?
The ATTORNEY-GENERAL: Mr. Lacey.
Mr. MILLER: He shall come back.

(4) The mixture was undoubtedly a mixture of air with other gases, forming an explosive compound.
(5) Whatever the nature of the explosive medium in the tube may have been, it could, and should, have been got rid of by efficient ventilation.
(6) The lack of proper ventilation in this tube in all the circumstances was entirely inexcusable; and the Post Office were grievously to blame.

EVIDENCE OF EXPERTS.

Having placed these propositions before the Commissioners, Mr. Miller proceeded to elaborate the facts upon which he based them. As regards Nos. 1 and 2, he said the Commissioners had seen the explosion area, and he was pleased to know also that they had the advice of Prof. R. V. Wheeler on the scientific side. On their part, the Gas Light and Coke Company had had the benefit of the opinions and advice of Prof. W. A. Bone, F.R.S., and Sir Dugald Clerk, F.R.S., both of whom would give evidence, though at the moment Sir Dugald Clerk was away ill. All he would say for the present, therefore, was that the line of damage done was fully consistent with the explosion having taken place in the Post Office tube, and that those scientific experts who were advising the Company had been able to reproduce in the laboratory precisely what had happened on Dec. 20 in the streets. It would be shown to the Commissioners that the results were typical of the explosion of a mixture of inflammable gas and air in a horizontal tube. Prof. Bone had carried out experiments in a 20-ft. glass tube, and had observed the results. These experiments had shown a precisely similar state of affairs—viz., a small amount of damage at the manhole which Thrower went down, then a distance on either side where the tube was not damaged, followed by considerable damage at the two ends of the tube, all of which fitted exactly with the actual facts as revealed in the streets. Prof. Bone's experiments would indicate that the explosion of an inflammable mixture in such a tube would lead not to one explosion, but to a first explosion followed by a vibration and rumblings and then a second explosion. This would be explained in detail by Prof. Bone.

Passing to the propositions Nos. 3 and 4, Mr. Miller said that the cubic contents of the tube were about 37,000 c.ft.; and Prof. Bone had calculated that it would require an admixture of 9 p.ct. of inflammable gas to produce the results that were to be observed. Assuming it to have been coal gas, this meant that there must have been present in the tube no less than 3330 c.ft. of coal gas, or thereabouts; and this brought him to a consideration of the possible

sources of inflammable gas which must be considered. These were —and he did not shirk putting coal gas first, because it was the one which occurred to everybody's mind immediately there was an explosion—(1) coal gas, (2) sewer gas, and (3) vapours of petrol, benzole, &c. With regard to (2), Mr. Miller said he used the term "sewer gas" in a general way, not in a scientific way, and did not suggest that it meant gas which came primarily from sewers. Indeed, he included in it what he was technically advised was anaerobic fermentation gases, which were obtained when there was bacterial action, in the absence of oxygen, upon any form of organic matter.

Reverting to the possibility of there being 3330 c.ft. of coal gas in the Post Office tube, Counsel recalled that there was not a single witness who had stated that before the explosion there had been any smell of coal gas, and that with the exception of the leakage at 216, Shaftesbury Avenue—which was a long way from the tube—there was no record of any leakage in the area of the explosion. Moreover, it so happened that the leakage of gas in Shaftesbury Avenue, even assuming it had been going on for a sufficiently long time to accumulate 3330 c.ft., without detection, would have moved uphill, and away from the tube, and not downhill towards it. The leakage at Shaftesbury Avenue, therefore, seemed to him impracticable as an explanation. It would have meant that large volumes would have existed all over this district for several days, and apparently without detection by anybody. Not only was there no evidence from the residents of the smell of gas, but there were no reports from any of the other authorities concerned with the roads in any way.

Percolation of Gas Through Soil.

At an earlier stage in the proceedings, the Chairman had asked the Chemist to the Gas Light and Coke Company whether gas could lose its distinctive smell after percolation through soil. At that time, Mr. Hollings had not made any scientific experiments, and could only answer generally. Since then, however, he had made arrangements for a scientific investigation into the matter, in order to ascertain whether masses of earth had any such effect upon coal gas; and the results would be placed before them. In the meantime, it could be stated that 6 lbs. of activated charcoal, which was one of the most powerful absorbents known, was necessary to remove the smell from a cubic foot of gas. Therefore, it was hoped to demonstrate that percolation through the soil would not rob coal gas of its distinctive smell. Incidentally, Counsel added that the experiments which had been carried out in the glass tube by Prof. Bone would be open to the inspection of anybody who cared to witness them repeated.

Another consideration was whether the gas in the tube was lighter or heavier than air. Rogers and Whalley that morning had stated that their gas indicators gave no evidence of gas being present in the Post Office manholes, which they repeatedly tested since last April; and this indicated that the gas in the tube could not have been lighter than air, such as coal gas, because it would have come to the surface. Again, had the gas in the tube been lighter than air, it must have been noticed when the manhole was opened on Dec. 20, when Thrower went down; but the evidence was that there was no smell of coal gas. Moreover, had there been the large quantity of coal gas which he had indicated would have been necessary to cause the explosion, it must have escaped through the keyholes of the manholes when they were cleared for the test; but neither Rogers nor Whalley, when they applied their noses, could detect it —and yet these were men thoroughly familiar with coal gas.

Foul Air in the Tube.

Mr. Miller then reviewed the evidence which had been given, emphasizing again the absence of anything pointing to a serious leakage of coal gas. At the same time he stressed the point that it was foul air in the tube which caused the trouble in November, 1926, when two men were got out of the tube with difficulty. In all the circumstances, he claimed that it was practically impossible to prove that there was coal gas in the tube. He therefore found it necessary to consider the possibility of anaerobic fermentation gases; and it was on this point that he would call Dr. J. S. Haldane, F.R.S., who had refused to accept any retainer on behalf of the Gas Company, but who thought it his duty to place his views before the Commissioners as an independent witness who had had a great deal of experience in this connection.

Dr. Haldane, in the first place, would say that the soil in the explosion area was porous, and that, from his experience of gases issuing from rocks and soil into wells and mains and tunnels, he was aware of the formation of fermentation gases under certain conditions, due to bacteriological action. For instance, wherever there was contaminated soil, such gases were formed which were largely composed of methane; and the condition of the barometer had an important influence. Whenever the barometer fell, this gas would issue out of the adjacent soil. In short, Dr. Haldane would suggest —and he held the opinion very strongly—that there existed in the area of the explosion all the conditions for the formation of these fermentation gases as the result of bacteriological action, and that under the weather conditions round about the date of the explosion these gases would be drawn from the surrounding porous soil towards the Post Office tube. It must be remembered that there were innumerable drains and sewers close by, and that all the conditions, including absence of oxygen, were present to bring about the state of affairs suggested. In this way it would be possible to get an explosive mixture with which the Gas Company would be in no way concerned, and over which they would have absolutely no control.

Possibility of Petrol and Benzole Fumes.

Then there was the possibility of petrol, benzole, and similar fumes percolating into the tube, because these volatile spirits were used by large numbers of people to-day in enormous quantities; and on this aspect of the matter there would be evidence from Mr. W. Doig Gibb that this possibility could not be ruled out of consideration.

Finally, Mr. Miller dealt with his propositions Nos. 5 and 6, in which the blame for the occurrence was definitely placed upon the Post Office. After pointing out that statutory undertakers having street boxes were compelled to maintain some form of ventilation, he said it was well known that gas undertakings were compelled to prevent the leakage of gas, and were under penalty if any leak notified to them was not rectified within 24 hours. At the same time, it was equally well known that it was impossible to avoid a slight amount of leakage; and this had been inherent in gas supply from the very beginning.

This was one aspect of the matter. It must also be the duty of any authority running tunnels in close proximity to gas mains to see that these tunnels were properly ventilated; but apparently there was no such statutory obligation upon the Post Office in respect of this particular subway. The London County Council were under such an obligation in respect of their pipe subway.

Counsel then read from the large number of documents that had been prepared as bearing on the case, and pointed to correspondence between the City Corporation, the Post Office, and the Holborn and the St. Pancras Borough Councils with regard to the foul state of the atmosphere in this particular subway both in and outside the city. As had been stated previously, the Holborn Borough Council actually acted on the suggestion of the City Corporation—before the Post Office took the tube over—and put in ventilators; but the moment the Post Office took the tube over they replaced the ventilators with air-tight manhole covers, and so left the tunnel unventilated.

Summing up the position in this respect, Mr. Miller said that at the time of the explosion there was nothing in the nature of adequate ventilation of the tube, though it had been suggested that it would be impossible adequately to ventilate it on account of dirt and water getting through ventilators of the grating type. From 1905 until 1925 there was continual correspondence between the Gas Company and the Post Office with regard to the question of ventilation generally, to avoid explosions in Post Office boxes; yet in 1921, when the Post Office took the tube over, they removed the ventilators and replaced them by air-tight covers. It was an inevitable consequence of this, he suggested, that the two men were overcome in 1926, due to the absence of oxygen; because there was no suggestion of coal gas being present then. It had been stated that the Post Office then took steps to ventilate; and what was done was to provide a blower which had to be operated in such a way that, before it could be put into motion, a man had to descend one of the manholes, and plug in the electrical lead to the machine. The risk attaching to this had been manifested in this case; and it was done under the instructions issued by the Post Office engineers. There was a report from the Research Department of the Engineer-in-Chief's Department of the Post Office in March, 1928, to the effect that the blower provided was insufficient to ventilate the tube, and urging that, in view of the bad state of the air in the section between Kingsway and Tottenham Court Road, the local sewer authority should be approached, to ascertain the source of leakage of foul air, with a view to preventing same.

With all this evidence before them, concluded Mr. Miller, the Gas Company submitted that the damage done by the explosion and fires was due to the action of the Post Office; and that if the tube had been adequately ventilated, whatever the nature of the gas which had accumulated, there would not have been the unfortunate accident.

The Chairman, speaking with regard to the second part of the reference to the Commissioners, said they would like to have some information upon the question whether the nature of the gas supplied in recent years had so changed as to have an effect upon the mains. In other words, a mixed gas was now being supplied which was drier and cleaner than the perhaps none too clean straight gas that was formerly supplied; and this might have some effect on the inside of the pipes. They would like some information as to whether joints stood as well as they did before, and also some information with regard to unaccounted-for gas.

Mr. Miller promised that all this information should be given, and mentioned other matters, such as the desirability of laying mains in subways, upon which he had already indicated the views of the Gas Company. Any other matter affecting the second part of the Commissioners' Warrant would be willingly investigated by the Company.

Wednesday, Jan. 23.

Evidence was first heard from the widow of the Post Office worker who died as the result of the injuries he received in the explosion, to the effect that no matches or mechanical lighter were found upon his clothes, and that the man himself had assured his wife in hospital that he was not smoking, and had not struck a match.

Expert Evidence for the Gas Light and Coke Company.

The expert evidence was then taken on behalf of the Gas Light and Coke Company. Prof. J. S. Haldane had prepared a report which was read by Mr. Miller.

Prof. J. S. Haldane, F.R.S., one of the three Gas Referees appointed by the Board of Trade under the Gas Regulation Act, Director of the Mining Research Laboratory, and a member of the Safety in Mines Research Board, said that, though as a Gas Referee he was precluded from accepting any remuneration from a gas undertaking, he agreed, with the concurrence of his colleagues, to appear as a witness in this inquiry, since it raised general questions relating to safety of gas distribution. Having examined the site of the Holborn explosion, and read very carefully the evidence submitted so far to the Commissioners, it seemed clear that at the time of the first explosion the Post Office tunnel was filled with an explosive mixture of combustible gas and air, and that this mixture was in some way ignited at the manhole after Thrower, the deceased workman, had gone down the iron ladder in order to turn a switch connected with the blower. How the ignition was produced was not, so far, clear. The mixture would burn gently at first, while Thrower was retreating

up the ladder, but, as usually happened with similar explosions, it gathered violence as the flame passed along the tunnel, so that he was blown upwards, and great damage done to the tunnel, roadway, and adjoining sewers and gas pipes. Large volumes of gas escaped from broken gas pipes and connections, causing secondary ignitions and explosions, and setting a house on fire. Flame seemed to have run backwards and forwards beneath the more or less pure lighting gas at the roof of the tunnel, and to have reached the surface at many places, burning there with a continuous flame, since there was an unlimited supply of oxygen. At first sight it might seem extraordinary that this tunnel should have been filled with an explosive gas mixture, while nothing similar had been experienced in recent times in any of the London sewers, as had been stated in evidence. The matter was intelligible, however, when the fact was taken into consideration that the Post Office tunnel was almost cut off from the outside air except when manhole covers were opened at long intervals. In sewers there were continuous currents of air from one street gully or ventilating pipe to others, and he could confirm, from numerous analyses, the statements made that the air of sewers is normally free from appreciable amounts of gaseous impurity. If, however, a sewer were kept almost closed up, like the Post Office tunnel, the inevitable result would be that the oxygen would disappear from the air, and that methane would then accumulate in the atmosphere, together with a small proportion of carbon dioxide, and some sulphuretted hydrogen. The mixture, when sufficient air was added, would be violently explosive; and gas of this kind from septic tanks was commonly employed for driving internal combustion engines at sewage works. There was no sewage or other material giving off combustible gas in the Post Office tunnel; but the walls were not air-tight, and the tunnel was in communication with the surrounding soil, and particularly at the deep manhole at Shaftesbury Avenue, which was capable of holding very large volumes of gas. With any fall in barometric pressure, such as there was on the night of Dec. 19 and the morning of Dec. 20, this gas would issue into the tunnel; and if the soil was contaminated by leaky drains, the gas would consist largely of methane, and would therefore be inflammable. It might be suspected that this issue of gas into the tunnel would be unimportant; but his observations on the gas found in wells proved that it was very important, and was, in fact, what made the choke-damp in wells so treacherous. The gas was simply the nitrogen of the air driven into the soil with a rising barometer, *plus* a little carbon dioxide formed in the oxidation process which occurred, and which removed the oxygen. The oxidation was, however, something practically unaccompanied by formation of carbon dioxide, as in the case, for instance, of the deep London clay.

When organic matter was present in soil, the oxidation was rapid, and when the oxygen was used up, or the soil was water-logged with contaminated water, the micro-organisms formed methane. Where, for instance, timber was buried in wet clay in mining operations, large quantities of methane or firedamp might be formed; and fatal explosions from this cause had sometimes occurred in Cumberland ironstone mines. In the soil beneath London streets, with air-tight roadways, it must easily happen that all the free oxygen disappeared. Methane was formed from decomposition of organic matter when such was present, so that combustible gas accumulated in the soil above the ground-water level. Even if free oxygen was present above the water-level, methane might be formed in abundance in soil underneath, if the water was contaminated. Water was standing on the floor of the deep manhole at Shaftesbury Avenue; and it seemed probable that this water was contaminated by, or originated from, leaky drains. If the methane was not being formed too quickly, it would disappear completely owing to bacterial action in the soil above, if oxygen was present there. For a similar reason the hydrogen, methane, and carbon monoxide from a small leak in a gas pipe would disappear completely, and this would not accumulate under an air-tight roadway.

From the evidence of Levett and Fisher in the present case, it was evident that for about two years the air of the tunnel had been more or less contaminated by air or gas which had been in contact with decomposing organic matter in the soil. The symptoms described in the gassing accident of 1926 were such as would be produced by air in which the oxygen percentage was considerably reduced, as indicated by the colour of the face of Fisher, and at the same time the carbon dioxide percentage was increased, as indicated by the great panting. The smarting of the eyes, and probably the headache and after-effects, were presumably due to the presence of a little sulphuretted hydrogen —a good deal less than one part in a thousand. The acetylene lamp which they carried would still burn in highly contaminated air. The air was not explosive, but might have been nearly so from the presence of methane. The fact that the air was worse at some times than at others was presumably due to the effects of barometric changes, already explained. The group of symptoms described would not have been produced by a mere escape of coal gas into the tunnel; and the smell was evidently not the very easily recognized one of coal gas.

PROF. HALDANE'S VIEW.

Considering all the evidence so far given, he had come to the conclusion that on the morning of the explosion the tunnel must have been filled with an explosive mixture of air with gas from anaerobic fermentation in contaminated soil, and that it was this mixture which ignited at the manhole. An extra volume of gas would pass into the tunnel, on account of the fall in barometric pressure at the time. Owing to admixture with carbon dioxide, this explosive mixture might have been almost as heavy as, or even heavier than, air; and this probably explained why the opening of the manhole for ten minutes was not effective in clearing it. Had the combustible gas originated from a broken gas main, the smell would have been evident in the street and neighbouring houses before any considerable quantity could have got in through the joints in the iron walls of the tunnel. The smell would also have been very strong at the manhole at first, and the manhole itself would have cleared rapidly. It seemed to him, therefore, that the practical lesson to be drawn from the explosion was that, in future, no similar tunnel should be left unventilated, and that the same sort of ventilation should be permitted as existed at present in sewers. The tunnel would then be as safe as a sewer was, though the air would still smell somewhat unpleasantly if the deep manhole on the Post Office tube near Shaftesbury Avenue remained.

The ATTORNEY-GENERAL questioned Prof. Haldane at great length on behalf of the Post Office.

The first point made was that Dr. Haldane had made up his mind as to the probable cause of the occurrence on the evidence so far produced; and Dr. Haldane added that, though he had not at the time he prepared his report been aware of the gas leakage at 216, Shaftesbury Avenue, that was too far away to have any influence upon the explosion, in his opinion, and would not have affected the conclusions he had come to.

The ATTORNEY-GENERAL: You dismiss the possibility of coal gas rather summarily on the understanding, I take it, that there were no gas leaks in the neighbourhood?—After consideration of the whole of the facts, and not merely that there was no smell in the neighbourhood.

Answering other questions, Prof. Haldane readily agreed that, assuming the possibility of penetration of coal gas into the tube, there would be no difficulty in attributing the results of the explosion to coal gas; but after consideration of all the facts, he found it impossible to conceive coal gas being there, and he was strengthened in that view by the evidence of absence of smell in the neighbourhood or at the manholes round about the time of the explosion.

Asked whether he, as a consequence, assumed that large quantities of so-called sewer gas are always being generated in this neighbourhood, Prof. Haldane said it all depended on the number of leaky drains in the district. In a place like Holborn, which was hundreds of years old, it might well be that there were leaky house drains; and if there were organic matter in the soil, in which there was little or no oxygen, then the generation of gas which he had called anaerobic fermentation gas would inevitably take place. For all that was known at present, the conditions in other parts of Holborn might be worse in this respect than in the neighbourhood of the Post Office tube. He did not suggest that all the gas of this nature in Holborn would percolate into the tube. He would imagine that it would also find its way into other cavities in the district. For the most part, however, such places as street boxes were near the street level, and might not be filled with such gas. Moreover, they were better ventilated than the tube was. It was possible, however, for the same conditions to arise in any unventilated cavities which were sufficiently deep.

The ATTORNEY-GENERAL pointed out that the tube had not been opened for a fortnight, and asked if that time was considered sufficient for the large quantity of gas that must have been present to have accumulated from the source mentioned by Prof. Haldane.

Witness said that it was if the tube was as unventilated as the evidence suggested.

The ATTORNEY-GENERAL: If the soil was contaminated with the substances necessary to generate this anaerobic fermentation gas, would you expect, after the explosion, to find some indications of it in the soil?—Yes, I think so.

Can you point to any place where there were such indications?—I have not had an opportunity of examining the whole place closely.

Would you attach any importance to the fact that there is no indication in the soil of pollution?—Yes, if the soil was proved to be pure and undiluted by anything, it would entirely dispose of my theory; but I think the fact that the tube has smelled for many years is sufficient evidence that there was decomposing organic matter in its neighbourhood.

Witness added that he believed the Gas Company were making some experiments to ascertain the presence of methane in the neighbourhood.

Discussing with the Attorney-General the occurrence in the tube in November, 1926, when two men were overcome, Prof. Haldane said that, from the description of the symptoms which had been given in evidence, it was extremely improbable that it was some other gas than anaerobic fermentation gas.

Answering questions by Mr. LIONEL WALFORD, Town Clerk of Holborn,

Witness said that the tube was generally recognized to be leaky; and in any case it must be leaky at the brickwork of the manhole chambers. He did not agree that it necessarily followed that if there had been generation of the large quantities of fermentation gas in the neighbourhood it would have been noticed at excavations made by other people—for instance, by the Borough Council's workmen—because such excavations were so thoroughly well ventilated through being exposed to the air all the time.

Mr. LIONEL WALFORD: But the soil would surely show some signs of impregnation?—I have no doubt it does.

Would your opinion be altered if the Borough Engineer said that, so far as he was aware or has observed, the soil bears no such traces?

Witness said that even pieces of wood buried in the ground would produce methane; and how much leakage there was from the house drains, he did not know. He admitted that the same conditions as were alleged against the portion of the tube in Holborn would apply in the portion in the city, provided, he added, that it was not ventilated.

The CHAIRMAN said that the Commissioners had inspected the portion of the tube in the city; and owing to certain conditions, including the fact that at one point the tube was connected to a telephone exchange, there was in fact a good current of air passing through, and the conditions were reasonably satisfactory there.

Mr. MILLER referred to a report of the Engineer to the City Corporation in 1910, which stated that the tube was then a public danger through being unventilated, and that the safety lamps went out or flickered when lowered. It was as a consequence of that report that the City Corporation suggested that the Holborn and St. Pancras Councils should ventilate the portions of the tube in their respective areas; and the City Corporation also took steps in the same direc-

tion, since when there had been little or no complaint so far as the city portion was concerned. That was before the Post Office took the tube over.

Speaking with regard to certain analyses of the air taken in the Holborn portion of the tube by the Post Office staff, Prof. Haldane said he doubted the accuracy of the figures obtained so far as the determination of the oxygen was concerned, over which mistakes were often made. In any case there could not have been coal gas present on that occasion—taken after the 1926 incident—because there was no hydrogen, and hydrogen was the main constituent of coal gas. To that extent the figures confirmed his view that coal gas did not penetrate into the tube. He added that he did not think the ducts leading from the Post Office tube would have a very important ventilating effect unless they were connected with something which would suck-in air in large quantities.

Witness told the Chairman that, assuming the chamber near the West Central District Post Office was filled with an explosive mixture of some kind, it would be possible to ignite it by a spark or even by a heated surface; and he further agreed that the rubbing of the ladder on the concrete floor in the manhole might cause such a spark. Continuing, he said the origin of the ignition of the explosive mixture had puzzled him a great deal; and this particular cause had not suggested itself to his mind, though it was a possible cause.

Replying to questions by the Chairman as to the loss of the use of the arms and legs gradually by the two men who were overcome in the tube in November, 1926, Prof. Haldane said that this would follow from the presence of H_2S and CO, because these two gases had a cumulative effect. All the signs, including the fact that the faces went blue, indicated a shortage of oxygen.

Lt.-Col. THOMAS (a Commissioner) asked whether in the case of fermentation gas one would expect to find traces of CO.

Witness said this had been stated to be so by certain German workers, though he himself had not verified it. There would only be very small quantities, however. He added that he would be inclined to trace the bad smell which was usually found in the tube to the fact that there was a very deep manhole at Shaftesbury Avenue, which might be the centre of the generation of fermentation gas, though this same type of gas might have been forming all along the length of the tube.

Referring to the apparent change of conditions from about 1926, Prof. Haldane said it might be found that some drain had become blocked up near the deep manhole; and on this point Mr. Miller recalled the fact that the Post Office engineers had called the attention of the Holborn Borough Council about that time to a possible leakage from the sewers.

Finally, Prof. Haldane, while agreeing that a gradual and slight leakage of coal gas even into a house might not be noticed by the occupants, said that any large escape which would be necessary to allow the accumulation of the large quantities spoken of in this case could not fail to reveal itself by smell.

EVIDENCE OF PROF. W. A. BONE.

Prof. W. A. BONE, F.R.S., Professor in the Department of Chemical Technology at the Imperial College of Science and Technology, was next called, and in answer to Mr. Miller, said that Prof. Wheeler, who was advising the Commissioners, had been one of his pupils.

Witness said that, on Dec. 31, he had visited the scene of the explosion, when, as far as was possible, he inspected the Post Office tube. He had also heard or read all the evidence, and had carried out certain experiments, in his laboratory, and also in the laboratory of the Gas Light and Coke Company, with a view to elucidating some points. As a result, he considered there was sufficient material upon which he could form a clear view as to where the explosion occurred, and in some other respects. There was, he said, not the slightest doubt in his mind that the explosion originated at or near the manhole close to the West Central Post Office, where the Post Office workmen had just removed the cover of the manhole, and that the explosion had propagated eastward and westward towards the two ends of the tube. The flame must have traversed through an explosive mixture of some inflammable gas and air or vapour and air which was homogeneously distributed throughout the tube. As to the time when the explosive mixture ignited, it was clear that it was ignited very shortly after Thrower descended the manhole, and not before; and having postulated the position and time of the explosion, Prof. Bone said there was no difficulty in visualizing that the consequences as seen on the spot would follow inevitably.

From this material alone, however, it was impossible to say whether the explosive mixture was coal gas, or petrol vapour, or the vapour of such light inflammable liquids, or the gas which Prof. Haldane had suggested. There was nothing in the character of the results of the explosion to differentiate between any of these three possible sources; but it was possible by scientific knowledge and reasoning to arrive at certain conclusions. With any inflammable gas there was a lower and an upper limit below which and above which gas would not ignite. For instance, any mixture containing between 5·4 p.ct. and 14 p.ct. of methane would be inflammable; but mixtures containing less than 5 p.ct. or more than 15 p.ct. would not be. From this, Prof. Bone went on to describe the experiments he had carried out together with his Assistant, Dr. Townend.

The gas as supplied to his laboratory by the Gas Light and Coke Company in the ordinary way on Jan. 15 was investigated, and experiments upon the upward propagation of the flame in a fairly wide cylindrical vessel, applying a taper to ignite the gas, were first carried out. Then, in his own laboratory, he experimented with a horizontal tube, 20 ft. long, built up of glass sections 4 ft. long by 2 ft. in diameter; means being provided by which the proportions of air and gas could be very slowly varied. With the upward propagation, it was found that the lower limit of ignitability was about 6 p.ct. with this coal gas, but with the horizontal tube he found that in order to get the slowest propagation of flame throughout the length of the tube it required 8½ p.ct. of coal gas. He was prepared, however, to take the figure of 7½ p.ct. as the limit; and he at once said that he could not, with that percentage of coal gas in the Post Office tube, expect to see the damage that was actually done. As a result of his investigations, without being dogmatic, he was decidedly of the opinion that the mixture which exploded in the Post Office tube on Dec. 20 last was one of which the lower limit of ignitability was in the neighbourhood of 9 p.ct.; and taking this figure, it meant that there must have been present in the tube 3360 c.ft. of coal gas. From his investigations, however, he found it very difficult to accept the idea that the explosion was due to coal gas.

Asked to give his reasons, Prof. Bone said that, in the first place, there was no coal gas supply inside the tube, and that the 3360 c.ft. of coal gas necessary to cause the explosion must have got in from outside. It was true that there were coal gas mains, large and small, in the vicinity of the tube, some of them crossing the line of the tube underneath, and others running parallel; but the latter mains were not very far below the surface of the roadway, and he found it impossible to suppose, assuming there had been a substantial leakage of coal gas sufficient to allow the quantity in question to enter the tube, that the whole neighbourhood would not have been reeking with coal gas, and all those living in the adjacent property seriously affected. As the cellars of this property were not filled with gas, and as there were no complaints of gas leakage, it was contrary to common sense to assume that the explosive mixture in the tube was coal gas; and he simply could not visualize the coal gas theory working at all.

With regard to other gases in the neighbourhood, he was also in somewhat of a difficulty of the same order with regard to Prof. Haldane's anaerobic fermentation gas theory, unless it could be shown that the decomposing organic matter had accumulated immediately below the tube. There would not be any great difficulty in conceiving fermentation gases in the neighbourhood of the deep manhole at Shaftesbury Avenue and other similar places if there were any, which would be equivalent to the decomposing organic matter being deep down below the surface; but he could not visualize the generation of such gas all the way along the route of the tube, though it may have taken place at localized spots. He had been informed that a number of old house sewers ran underneath the tube before joining up with the main sewers; and these old drains would be liable to be defective, and to leak, and therefore might create the conditions favourable to the generation of fermentation gases.

Next, Prof. Bone said that serious consideration must be given to the possibility of the presence in the tube of vapours of petrol and other volatile spirit which had found their way into the drains, in the first place, and percolated the soil subsequently, because large quantities of such spirits were used everywhere to-day and were extremely liable to find their way into the drains from such premises as garages. Assuming ordinary petrol to approximate to the hydrocarbon hexane, C_6H_{14}, a mixture of 1·5 p.ct. of this vapour with 98·5 p.ct. of air would constitute an explosive mixture such as would cause all the damage done in Holborn. On the basis of the size of the tube, it would require the vapour from 17 gallons of petrol to create the required mixture; and although there were difficulties in accounting for this explosion, he felt there was much less difficulty in visualizing the presence of the vapour from 17 gallons of petrol than in visualizing the presence of 3360 c.ft. of coal gas. A mixture of hexane and air would be much more easily ignitable than coal gas and air, and also more easily ignitable than fermentation gases, which, in turn, were less readily ignitable than coal gas, because these fermentation gases would contain 20 to 30 p.ct. of CO_2; the remainder being methane.

POSSIBLE CAUSE OF IGNITION.

As regards the possible cause of ignition of whatever mixture was in the tube at the time of the explosion, Prof. Bone said that, if all the statements of the witnesses that there was no naked light, that no match had been struck, and that there was no short circuit on the electric cable, were taken as proven facts, then another serious difficulty was placed in the way of the coal gas theory. It had been suggested that a spark might have been caused through the nails of Thrower's boots striking on the iron ladder, or that a spark might have been caused through the bottom of the ladder rubbing on the concrete floor; but such a spark would not have been sufficient to explode a mixture of coal gas and air, though it might easily cause an explosion of petrol vapour and air.

There was, however, continued Prof. Bone, another occurrence to which he attached considerable importance as regards the possible cause of ignition of whatever mixture was present in the tube; and he did not think they need go much farther in seeking a cause. It was the evidence that just as Thrower was entering the manhole, Fisher had an acetylene lamp from which he had taken the used carbide, and was proceeding towards a scavenger's barrow to dispose of it. It was conceivable that, in doing this, some of the carbide—which might not have been entirely spent—was accidentally dropped, or was blown, into the manhole. The bottom of the manhole being damp, the carbide would at once begin to generate heat and acetylene, which would not be pure acetylene, but would contain traces of phosphoretted hydrogen and sulphuretted hydrogen. The carbide might itself glow—he had seen carbide glow when it was slightly wet, and he had actually caused spontaneous ignition of carbide. Therefore, he thought it likely that there was such a cause of the ignition of the explosive mixture in the tube; and when he heard of carbide being thrown about in this manner, he was not surprised at the tube blowing up. This condition would much more easily cause an explosion of a petrol-air mixture than of a coal gas-air mixture. If, therefore, it was to be assumed that there was no naked flame or short circuit in the tube, then the carbide theory would have to receive very serious consideration, though the easiest and simplest explanation, naturally, would be that a match was struck. With a friction spark, however, there would at once be introduced a very great difficulty in conceiving that the explosive mixture in the tube was coal gas and air, because such friction spark would be most unlikely to ignite it.

Prof. Bone then explained in some detail how, from their know-

ledge of the propagation of flame, it was conclusive in his opinion that the explosion started in the Post Office tube, and that the nature of the damage caused was indicative of this. In an explosion starting at such a manhole, open to the air, and with a length of tube on either side, there would first be the initial stage of inflammation in which the flame started and travelled slowly in both directions. That was consistent with the fact that for some 60 yards on either side of the manhole there was no damage to the tube or the pavement. During this period there was only a quiet burning. Then the flame would begin to vibrate backwards and forwards with increasing amplitude. This was known as the vibratory stage; and while the first stage hardly constituted what ordinary people would call an explosion, at the second stage the explosion became more violent. This was seen by the fact that the roof of the tube and the roadway were damaged beyond the distance of 60 yards or so from either side of the manhole. With this second stage would be associated sound, or the rumblings which witnesses had spoken of; and then finally there was a third stage, at which there was the maximum violence of the explosion, and the flame would advance with very high velocity. The results of the explosion as seen in the tube and the roadway were precisely consistent with these facts, which were known as the result of scientific investigation over a long period; and they had been reproduced by him in his laboratory in his 20-ft. glass tube experiment.

Bad Ventilation of the Tube.

Speaking with regard to the accumulation of an explosive mixture of any kind in the tube, Prof. Bone said that the Post Office officials had done everything they ought not to have done, and had done nothing that they ought to have done. There had been evidence since October, 1926, that gas of some kind was accumulating in the tube; and the most elementary precaution would have been to see that the tube was thoroughly ventilated. If that had been done, the explosion would not have occurred. It was true that there was a regulation that the air should be tested by means of a safety lamp; but one was not used on this occasion, and he criticized the Post Office system which permitted workmen to enter these manholes without someone in authority to see that proper precautions were taken. As regards the analyses of the air in the tube which had been taken after the 1926 incident, Prof. Bone said he would like to know, with Prof. Haldane, how the oxygen had been determined. These analyses showed more CO_2 than methane, and a very small quantity of hydrogen—very much smaller in one case than half, and in another case less than one-tenth, of the methane; and the relation between the CO_2 and the methane excluded any possibility of coal gas being present. The conditions when these analyses were made more nearly approached the presence of anaerobic fermentation gases. Had coal gas been present, he would have expected some 3 p.ct. of methane, and the hydrogen would have been of the order of twice the methane; whereas according to the analyses in question, the figures were in the inverse order from what they should be for coal gas.

Prof. Bone contended that the Post Office was at fault in omitting the elementary precaution of properly ventilating the tube, in fixing the position of the plug in the tube in such a way that a man had to enter the tube to make the connection, and in allowing workmen to work in these manholes without proper supervision to ensure that safety precautions were taken. He added that if the Post Office officials had properly visualized this problem as the result of the 1926 occurrence, the obvious thing to do would have been thoroughly to ventilate the tube.

The Attorney-General then asked Prof. Bone to indicate means by which the tube could have been ventilated otherwise than by using the blower, but Prof. Bone said that, though there were obvious methods, such as by using a fan, he was not an engineer, and had not considered the point in detail.

The Attorney-General went over every opinion expressed by Prof. Bone in his evidence in chief, but failed to induce the Professor to change any of them..

The Attorney-General asked Prof. Bone on what grounds he supported his criticism of the position of the electric plug in the tube.

Witness: The plug could have been put immediately under the manhole; and I support my criticism on the basis of common sense.

The Attorney-General: Is that the only reason?

Prof. *Bone:* It is the principal one, and good enough, I think.

The Attorney-General: You are not prepared to express any confident opinion as to the cause of the explosion?

Witness: I have said that I will not express any dogmatic opinion; but I am fairly confident that it was not due to coal gas and air.

Thursday, Jan. 24.

Prof. *Bone* said that practically all the gases he had been considering would be ignited easily by a naked light. There had been some difference of opinion among scientific men as to whether the igniting power of an electric spark depended upon its temperature primarily, or upon its ionizing power. He believed it depended to a secondary degree only on temperature, and primarily on ionizing power. In order to ignite any explosive mixture of gas or vapour and air, a certain minimum spark energy was required, so that a mixture might not be exploded by a weak electric spark, but would be exploded by a stronger spark. He believed it could be assumed that, if an electrical short-circuit had occurred in the Post Office tunnel during the operation of inserting the plug into the sockets to obtain power for the air blower—though he understood that this possibility was ruled out—the energy of such a short circuit must have been sufficient to fire any of the gases the Tribunal had been considering. Sparks which might arise from the contact of the nails in a man's boots with a concrete floor, or from the friction between an iron ladder and a concrete wall, were not of great intensity. While they might, and probably would, ignite a petrol-air mixture, he was very doubtful whether they would ignite a coal-gas air or a fermentation-gas air mixture. With regard to the suggestion that carbide might have caused ignition, he said that, if the carbide glowed, as it might conceivably do, he believed the temperature attained would be sufficient to ignite a petrol-air mixture, but not sufficient to ignite a coal-gas air or a fermentation-gas air mixture.

Questioned by Col. Thomas as to his reasons for believing that there must have been a homogeneous mixture of gas throughout the tube,

Witness said he had crawled inside the Post Office tube for a considerable distance on each side of the manhole at which the accident had occurred, until he had reached a point in each direction at which the tube had collapsed. His opinion as to the homogeneity of the mixture was based upon the evidence he had seen of a fairly symmetrical explosion having occurred from that manhole. From what he had seen of the general symmetry of the initial propagation, and from the fact that the tube had collapsed at both ends, the conclusion was irresistible that the tube was filled throughout with a fairly homogeneous mixture.

Evidence of the Use of a Lighter.

At this point new evidence was interposed with regard to the occurrences on the morning of the explosion, which evidence threw some new light upon the problem as to how the gas in the tube was ignited. The witnesses were three labourers employed by the Charing Cross Electricity Supply Company, Ltd.; and the salient point was that shortly after the explosion they had met a workman running from the scene of the accident, who had stated that the man injured in the tube (and who has subsequently died) had used a lighter.

It was stated by Mr. W. Craig Henderson, K.C. (Counsel for the Charing Cross Company), that only recently had it come to the knowledge of the Company that three of its employees were in a position to give evidence as to the events on the morning of the explosion. Each of the men had made statements, and the Company thought it right to tender their evidence to the Commission.

Thomas Downing was the first of these witnesses. He was at work in the vicinity when the explosion occurred, and, together with the other two employees mentioned, ran towards the scene of the explosion. On reaching Broad Street, they had met a man coming away from the direction of the manhole at which the accident had occurred. The man was not hurt, but when questioned by one of witness' companions (Brooks) as to what had happened, he had stated: "I was standing over the top of the manhole; I saw my mate using a lighter, and before I could shout down the whole thing went into flame."

The Attorney-General asked why witness had not mentioned this matter earlier.

Witness replied that, inasmuch as he and his companions were away from their work to visit the scene of the explosion in their employers' time, he felt that had he mentioned the matter he might have got into trouble.

It was stated that the Post Office workers who were working at the manhole were in Court; and witness was asked if he could recognize the man who had made the statement referred to. Witness, however, was unable to do so.

Witness said he had not mentioned his experience earlier because he had feared that the man who was said to have used a lighter in the tube might have been dismissed, or that, since he had died, his family might not have been compensated.

James Rowell (another of the Electricity Company's employees, who was with Downing on the morning of the explosion) said he had heard the man whom he and his companions had met refer to a lighter, but had not heard the whole of his statement.

W. A. Brooks corroborated the previous evidence. His recollection of the man's statement was: "My mate went down the hole, and I was on the top; he struck his lighter and became all alight."

Evidence of Mr. Doig Gibb.

Mr. *W. Doig Gibb* (Past-President of the Institution of Gas Engineers) then gave evidence, and was examined by Mr. Cyril Asquith (Counsel for the Gas Company).

The explosive gases of which he had had experience, said witness, included coal gas, sewer gas, bituminous vapours or gas, the gas formed by the electrolysis of water by electric current, and vapours given off by petrol or other light spirits. In connection with the latter, he mentioned an experience at Bradford, where spirit was used for the washing of wool, and where a series of explosions had occurred in the sewers. The trouble was not definitely proved to be due to petrol gas, but it was a fact that some manufacturers had put soiled petrol down the drains, and when the authorities had taken steps to prevent this the explosions had ceased.

Having regard to the circumstances of the Holborn explosion, he expressed the view that the possibility of its being due to bituminous vapours or gases produced by electrolysis could be dismissed. The most probable cause was sewer gas. There might have been petrol vapours or very small quantities of coal gas present, but the dominating factor was sewer gas. He was absolutely certain that the explosion occurred in the Post Office tube. Asked for his view as to the method of ignition, he said it was his experience that workmen needed a good deal of training before they would recognize the danger of using lights near explosive gases.

The danger from loose gases under the road surfaces to-day was less than it was formerly; leakage had become less; and the nature of modern roads was such that gases were able to travel underground, and might travel considerable distances before finding a vent. In these circumstances, however, the existence of unventilated or ill-ventilated structures underground became more dangerous, and modern developments made it more and more necessary to provide adequate ventilation for such structures. Sewer gas was a more substantial danger nowadays than formerly. Witness said that, without wishing to pose as an expert chemist, the analyses of the gas in the Post Office tube in 1926, when Post Office employees were overcome, suggested to him that the gas was sewer gas. He did not consider

that anything effective had been done to change the conditions in the tube since.

Had there been an escape of coal gas sufficient to fill the Post Office tube with an explosive mixture before the recent explosion, he would have expected the men working in the excavations at the joints of the 48-in. gas main to smell it. Though the main was lying in the blue London clay, he believed that puddle clay had been placed round the joints as an extra precaution. In the friable soil, gas would invariably rise. In London the soil was friable at the top, and became more and more consolidated at increasing depths. Any gas escaping from a main in the soil would creep along the underside of the concrete road bed until it found a vent. The amount of gas which would have to get into the tube to form an explosive mixture would be about 3000 c.ft. One could not assume, however, that if gas leaked from a main it would all find its way to the tube. There would be large quantities of gas elsewhere, which, one would expect, would find its way into cellars, &c., and be detected easily. In general, he agreed with the evidence of Mr. Lacey, except as regards the effect of heavy traffic. In his (Mr. Gibb's) view the amount of damaging vibration had increased.

The CHAIRMAN said he thought it could be accepted that the mains were constructed of perfectly good material. Also, with regard to the Gas Company's organization, he said the Commissioners were impressed with the way in which the matter was handled after the explosion.

Questioned by Counsel as to the possibility of sectional valving, witness pointed out that the Gas Light and Coke Company's system comprised nearly 4000 miles of mains, covering a huge area, and the magnitude of the system would render it impracticable. There was also the danger that, no matter how careful the Company might be to send notices to consumers, the gas taps on consumers' premises would remain turned on while the gas supply was cut off, and would be left on, so that when the gas supply was renewed the gas would escape through consumers' appliances.

With regard to the escape of gas which had been referred to as having occurred outside premises at 216, Shaftesbury Avenue, witness said he had formed the very definite opinion that it could not possibly have had any connection with the explosion. The gas had escaped from a 4-in. main under the pavement, at little depth. If it had been responsible for the explosion, it would have had to travel in a downward direction, instead of upwards, then leak into cast-iron pipes, which were presumbly gas-tight; and even if it did get into those pipes, which connected with the tube, it would have had to travel in a downward direction towards the tube, instead of in an upward direction, as would be expected, by reason of its low specific gravity.

At this point the CHAIRMAN intimated that the Commissioners would like to take advantage of the Gas Company's offer of facilities to see experiments carried out by Prof. Bone, similar to those on which he had based a good deal of his evidence.

Mr. MILLER said that the apparatus was available; and the Company would be happy to welcome the Commissioners at any time.

It was intimated that Prof. Bone would demonstrate the experiments early in the week commencing Jan. 28.

Mr. *Doig Gibb* was re-examined with regard to the formation of gas in the ground before and after the explosion. His point was that, whereas prior to the explosion the condition in the ground was anaerobic (the oxygen in the air having been exhausted in the absence of ventilation), as the result of the upheaval of the ground and the admission of oxygen, that condition had ceased to exist, so that it had become impossible to draw from the ground samples such as existed prior to the explosion.

Asked if he considered that modern traffic conditions had increased the risk of leakage due to fracture of gas mains and the loosening of joints, he expressed the view that the risk had increased, probably due more to leaky joints than to actual fractures. He would certainly advocate that mains laid to-day should be laid deeper than mains laid when traffic conditions were less severe. Where there was a bed of (say) 12-in. of concrete, supporting a surface of asphalt or wood blocks, it was necessary to protect the main only from the effect of vibration; and one could count upon the road surface and foundation to protect it from crushing effects. Much would depend on the nature of the filling-in; but under good soil conditions, where vibration was not transmitted too freely from one part to another, he suggested that a layer of from 2 to 3 ft. of soil from the top of the main to the underside of the concrete would be sufficient. He agreed that the twisting and turning of pipes to avoid obstructions underground—as, for instance, other services—increased risks of damage to pipes. Asked for his opinion as to the use of subways for carrying the various services, he expressed the opinion that, even having in view the improvements effected in the manufacture of electric cables, gas pipes and electric cables would never live at peace in the same conduits. He added that there had also been serious accidents to gas mains, due to water leakage.

The CHAIRMAN said the answer seemed to be that witness would be delighted to see other services in subways, but he would not agree that gas pipes ought to be placed there as well.

Witness replied that he liked to see gas pipes surrounded by solid ground, and away from all cavities.

TEST CARRIED OUT BY MR. HOLLINGS.

Mr. *H. Hollings* (Chief Gas Chemist, Gas Light and Coke Company) gave details of samples of air taken from the ground in the affected area. These analyses, said Mr. Hollings, afforded some evidence of the existence of anaerobic conditions, as suggested by Prof. Haldane. The possibility that the combustible gases which had exploded had originated from coal gas had been very much in his mind; but there were several reasons why he did not accept that as being a complete explanation. One reason was that the ratio of methane to hydrogen in the samples was different from that in coal gas. Another reason was that the oxygen concentration in some of the gases indicated a deficiency when compared with the concentration of oxygen in air. The analyses provided some support of Dr. Haldane's theory as to the possibility of the production of methane through anaerobic fermentation. The analysis of the gas escaping from the collar of the 48-in. main was a fairly typical analysis of the Company's gas. The Post Office, he added, had samples of air taken from the tube, and had them analyzed, in 1926; and the proportions of methane and hydrogen in those samples were different from those which existed in coal gas.

Reference was made to other samples which had been obtained by the Post Office; and he agreed that the analyses, if they were correct, gave some support to the theory that coal gas was present. He was doubtful, however, as to whether they were correct, because in the statement of the analyses there was no record of any search having been made for the presence of unsaturated hydrocarbons. If no such search was made, then what was returned as carbon monoxide might, in fact, have been acetylene. He mentioned this because he understood that acetylene had been used from time to time in the Post Office tunnel.

Mr. Hollings then described some experiments he had carried out, as the result of questions put to him by the Chairman at an earlier stage of the inquiry, to determine the extent to which the smell of coal gas might be removed by contact with earth. As a result of these experiments, he had come to the conclusion that the suggestion that the smell could have been removed from 3330 c.ft. of coal gas during its postulated passage through the earth surrounding the Post Office tube was absolutely untenable. It was still more difficult to conceive the possibility of removal of smell by the same earth from the much larger volumes of gas which must have failed to find entry to the tube during the postulated entry of the 3330 c.ft.

Friday, Jan. 25.

Mr. *Hollings*, continuing his evidence, spoke of the change from the illuminating power standard to the calorific power standard; and said that in 1921 a calorific value of 475 B.Th.U. was adopted, which was changed in 1922 to 500 B.Th.U., under the provisions of the Gas Regulation Act. At Beckton, part of the benzole was removed from the gas, but at the other works it was not removed. As a chemist, he was unable to see anything in the differences in recent years in the composition of the gas likely in any way to affect the action of the gas upon the mains. There had been no change within the last twenty years which was at all likely to have had any effect upon a purely metallic joint. Prior to 1909, and more particularly prior to 1906, there might have been in the gas larger proportions of the unsaturated hydrocarbons, which to a small extent might have condensed out.

In answer to Mr. LIONEL WALFORD, for the Holborn Borough Council,

Witness said that, though he would expect to find iron oxide in the damp Post Office tube, he would not expect this to have any effect upon any coal gas that might be present in the tube—assuming there was any—for the reason that the Gas Company were under statutory obligation to remove all the hydrogen sulphide from the gas before it was distributed to the public, and there were no other elements in the gas which could be acted upon to any great extent by iron oxide. Nor did he believe that the smell of coal gas could be removed by any oxide of iron, either in the Post Office tube or even from the gas pipes themselves, assuming the gas escaped and came into contact with oxide of iron which might have been present on the outside of the gas pipes. It was inconceivable that there was sufficient iron oxide in the Post Office tube to remove the smell from the large quantity of gas which had been mentioned as necessary to cause the explosion. Nor could he believe that the reason why the gas in the tube on the occasion in 1926, when Fisher and Levett were overcome, was not recognized as coal gas was because the iron oxide had removed the characteristic smell.

FURTHER EVIDENCE FROM MR. LACEY.

Mr. *Stephen Lacey* was then recalled. He said that since he last gave evidence he had considered the ventilation of the Post Office tube by natural draft, and had come to the conclusion that, had the tube been ventilated by natural means, there would have been no trouble. He emphasized this by describing a visit to the portion of the tube east of Kingsway, with the Commissioners, where there was a sufficient current of air to be indicated by the flame of a lighted match; the flow of air being about 1 ft. per second. A similar state of affairs could easily be introduced in the portion of the tube which exploded. He did not agree with the suggestion of the Attorney-General that more or less open manhole covers to the tube would let in water and damage the cables. As a matter of fact, the ventilation so afforded would have the effect of drying out any moisture which might get in.

Reference was then made to the break in the main at 216, Shaftesbury Avenue, on Dec. 16.

Witness said his attention was first called to this leak when the documents in this case were being prepared in conjunction with the Post Office officials. He was entirely satisfied, however, that the leak could not be the reason for the possible accumulation of 3360 c.ft. of coal gas in the Post Office tube. While he would not say that no trace of gas could have got into the Post Office tube from that leak, he was satisfied that no substantial amount of gas could have got into the tube from it. After pointing out that the point of leakage at 216, Shaftesbury Avenue, was a hundred yards or so away from the Post Office tube, witness said that, if air was passed into solid earth at the rate of 50 c.ft. per sq. ft. per hour, at a pressure of 5-in. water gauge, the rate of flow would be reduced to 1 c.ft. per sq. ft. per hour, 4 ft. away from the point of entry.

The actual conditions as regards the position of the gas mains—the Post Office ducts under the pavement there being 6 ft. below the gas mains—were then discussed from the point of view of the distance the gas might have percolated through the earth, which at the level of the Post Office ducts would have been more compact

than nearer the surface. Witness put the leakage from the crack in the main at less than 50 c.ft. per hour, and he contended that most of it went into the cellar of the house. The next question was that, if the gas could find its way down into the earth and surround the Post Office ducts, it could only enter the ducts, assuming they were defective, by diffusion, because there would be no pressure behind it; and the quantity so likely to enter the ducts would be negligible. Having entered the duct, the gas would tend to travel up the gradient of the duct. There was also a Post Office manhole 20 ft. away; and any gas there would tend to find its way into the ducts, and be carried away also up the gradient into New Oxford Street, away from the scene of the explosion.

Questioned as to the ventilating effect on the Post Office tube of the ducts leading from it, Mr. Lacey said it was laughable, because the pipes led from the unventilated tube to unventilated manholes. With regard to unaccounted-for gas, the figures from "Field's Analysis" were given in relation to the years 1918-27, from which it was seen that the figures for the Gas Light and Coke Company were 4·39 p.ct. in 1927, 3·85 p.ct. in 1926, and 5·03 p.ct. in 1925.

Mr. MILLER pointed out that the returns from the Provinces varied between such limits as 9·90 p.ct. and 2·10 p.ct. over the period of the last three years. In 1918, the figure for the Gas Light and Coke Company was 8·02 p.ct.; but it had since fallen gradually to 4·39 p.ct. in 1927, which was a slight increase over 1926.

LEAKAGE AND UNACCOUNTED-FOR GAS.

The CHAIRMAN said the Commissioners would like to know how much of the total unaccounted-for gas could be allocated to leakage.

Witness said that no indication was given in "Field's Analysis" of the amount of leakage, which was included in "Gas unaccounted-for," but he had endeavoured to form a judgment of this, so far as his Company was concerned, between the station meters—including gasholders—and the consumers' meters. As a result, he had come to the conclusion that the leakage from mains was not more than ½ p.ct. of the total gas made, while the leakage from service pipes, he estimated, would be less than ½ p.ct.—or a total of less than 1 p.ct. Expressed per mile of main, for his Company this would be about 14 c.ft. per mile per hour. He had contributed an article on the matter ten years ago to the "JOURNAL" (see Vol. 144, p. 118).

Witness then mentioned that, in company with the Commissioners and representatives of the Post Office, he went to the spot where the 48-in. main crossed underneath the tube near Princes Theatre. A searcher-bar was driven into the ground below the level of the tube in several places; and a Post Office gas indicator showed 5 p.ct. of heavy gas coming out.

The CHAIRMAN: We agree that is an accurate description of what happened.

At this point it was arranged to see Prof. Bone's experiment at the Imperial College of Science on Jan. 28.

The ATTORNEY-GENERAL then questioned Mr. Lacey, both on his evidence given on Jan. 25 and on his previous evidence. It was suggested to witness that the present methods of road making had the effect of preventing gas escaping so readily as in the days of macadam roads.

Witness agreed that the gas would thus accumulate in various parts underground, and that any leak was more easily detected, whereas previously it leaked through the surface of the road and was not easily detected; but by this he did not mean that, if the roads were opened, coal gas would be found in pockets in many places. He still held the view that he expressed in the article in the "JOURNAL" ten years ago, already referred to—viz., that a small leakage of gas often caused trouble a long distance away.

Witness emphasized the point that the tube could have been ventilated efficiently; and when the Attorney-General asked if he were qualified to express an opinion on that, Mr. Lacey said it only required a knowledge of elementary science.

The use of ventilated manhole covers was then dealt with; and witness said that the Westminster Electric Supply Corporation used a ventilated type of manhole cover; and he believed there had been no explosion in any of their manholes.

The ATTORNEY-GENERAL suggested that in the view of the Post Office engineers such manhole covers were not practical, a view which, he said, was shared by the engineers of the Electric Supply Companies who had been called.

Witness said he did not agree with these opinions.

The CHAIRMAN put some questions with regard to the influence of the depth mains were laid below the surface of the road, as effecting possible damage from traffic.

Witness said that the depth at which mains were laid was only one factor affecting possible leakage, &c., due to vibration; and it was possible to exaggerate it. If the soil below the surface was virgin soil, there would not be any advantage in going down below 2 ft. 6 in. from the concrete foundation.

Mr. MILLER here indicated that this was all the evidence he had to offer, subject to the report on the test on the 48-in. main.

BUDLEIGH SALTERTON GAS COMPANY.

Proposed Revision of Maximum Price.

An application by the Budleigh Salterton Urban District Council for a reduction of the maximum price chargeable by the Budleigh Salterton Gas Company was the subject of inquiry at the Board of Trade Offices, Westminster, on Friday, Jan. 25, by Mr. J. F. RONCA (Director of Gas Administration at the Board of Trade). The application was made a considerable time ago, since when the parties have endeavoured to reach an agreement upon the matter, but without success.

The Urban District Council was represented at the inquiry by Mr. A. Valon (Messrs. W. A. Valon & Son, Westminster) and Mr. F. G. Hill (Clerk to the Council). The representatives of the Gas Company were Mr. G. Evetts (Consulting Engineer) and Mr. G. E. Carpenter (Engineer and Manager). Necessarily, the inquiry consisted in the main of the detailed examination of estimates of costs, drawn up by the two experts, Mr. Valon and Mr. Evetts, to show what the maximum price should be; and it resolved itself into a friendly and frank discussion of the figures produced.

Mr. *Evetts* said that the Urban District Council asked for a reduction of the Company's existing maximum price of 19d. per therm, which was fixed in 1921. The pre-war maximum was 5s. per 1000 c.ft. Before the war, gas was sold at 4s. 5d. per 1000 c.ft., so that there was a margin of 7d. between the selling price and the maximum price of 5s. At present the selling price was 18d. per therm, the maximum price being 19d. per therm, so that the margin between the two was equivalent to 4·6d. per 1000 c.ft.; the quality of the gas supplied being 460 B.Th.U. per c.ft. The Directors felt that they could not reduce the selling price below 18d. per therm at the moment, and, therefore, could not agree to a reduction of the maximum price. Mr. Evetts produced tables in which he drew a parallel between the 1913 costs of gas supply and the costs at present prices, based upon the 1927 results (the 1928 results not yet being available). The net cost in 1913 was equivalent to 5·18d. per therm, and the estimated cost at current prices, based on the 1927 results, was 12·32d. per therm, so that the increased cost, exclusive of loans, was 7·14d. The increase due to loans was 0·16d., making the total increase 7·30d. Thus, the present maximum price should be the pre-war figure of 5s. per 1000 c.ft.—*i.e.*, 12d. per therm—*plus* 7·30d., making 19·30d., whereas the existing maximum price was 19d.

Though the accounts for 1928 were not available, Mr. Evetts said that the quantity of gas made in that year was 3 p.ct. less than in 1927; and, judging from rentals so far, it was expected that the sale of gas in 1928 would be the same as in 1927, so that there were indications of the reduction of the very high leakage figure which obtained in 1927. Carbonizing results had improved since 1913, but in recent years the leakage had been very considerable. The reason for the large leakage was that there were considerable lengths of main in Budleigh Salterton which were insufficiently covered to withstand the effects of present-day traffic; for there was not the least doubt, judging from the investigations made by the Resident Engineer, that the leakage was due to the breaking of pipes and the opening of joints. During the past 18 months the Engineer had spent a great deal of money with a view to reducing leakage, and he believed that the leakage in 1928 would be found to be less than it was in 1927, and probably less in 1929 than in 1928. The cost of repairs and depreciation of works, mains, meters, and stoves in 1913 amounted to 9·99d. per 1000 c.ft., but in the three years from 1925 to 1927 the average had amounted to about 24d. His estimate of present cost of repairs and depreciation was 18·33d., an increase of 83·4 p.ct. over the 1913 figure.

The estimated cost of gas at present—*i.e.*, 12·32d. per therm (57·34d. per 1000 c.ft.)—was 10d. per 1000 c.ft. less than the actual cost in 1927.

Mr. *Valon* said that there appeared to have been an increase in costs since 1921, and he pointed out that the reduction of prices all round should have resulted in a reduction of costs comparable with that effected by other companies, to which Mr. Evetts agreed, other things being equal. Reference was also made by Mr. Valon to the dividends paid by the Company, and he pointed that, whereas in 1913 and 1921 the dividend was 5 p.ct., in 1922 and 1923 it was increased to 7 p.ct., and had since increased until it had reached 10 p.ct. in 1927. It was the intention, he understood, to pay 10 p.ct. for 1928. Mr. Evetts agreed; and said that at a previous inquiry, this had been used in evidence against the Company, in that it had not paid the full dividend, and for that reason it was decided that the shareholders should take more money out of the Company. It was urged by Mr. Valon that in the case of a small company which could pay maximum dividends, there was not the same inducement to reduce the price of gas as there was in the case of a sliding-scale company.

Another matter to which Mr. Valon called attention was that from 1925 to 1927 there had been a reduction in the output of gas, and that this reduction in output would tend to increase the cost per therm.

Mr. *Evetts* attributed the reduction to electrical competition, which had commenced a little more than two years ago.

Mr. *Valon* suggested that an increase in the price of gas in 1926 had resulted in decreased consumption in that year, and that more gas would have been sold in 1926 than in 1925 but for that increase of price. Also, he did not consider that the present selling price of electricity in the district (10d. per unit) should result in serious competition, if the price of gas were reasonable.

Mr. *Evetts* replied that undoubtedly the advent of electricity did have an effect on gas sales, and he would guarantee to sell electricity at 18d. per unit. While agreeing that the general experience throughout the country was that, in the face of electrical competition, gas sales had increased, the advent of electricity in a district did retard the progress of the gas undertaking for a year or two.

Mr. HILL suggested that progress in building in Budleigh Salterton in 1924, 1925, and 1926 had been considerable.

Mr. *Carpenter* agreed that progress had been great, but stated that in the last 18 months or so it had decreased.

Mr. *Valon*, dealing with the general question as to the method of arriving at the proper maximum price, said that if one could calculate directly the reduction in costs of gas supply that had occurred since the present maximum price was fixed in 1921, one was justified in applying an equivalent reduction to the present maximum price.

Mr. *Evetts* admitted that there had been a general reduction in the costs of producing gas since 1921, but he pointed out that if, in 1921, the maximum price was not increased above the pre-war maximum in the same degree as costs had increased, then one was justified on the present occasion in determining the increase in costs as between 1913 and the present time, and asking for an equivalent increase in the pre-war maximum price.

Mr. *Valon* said he had made a direct estimate of the reductions in cost which had occurred since 1921, owing to reductions in prices, and had deducted that amount from the estimated costs submitted by the Company in 1921, when they had claimed a maximum price of 20d. per therm. The Board of Trade, however, had allowed a maximum price at that time of 19d.

Mr. RONCA said that originally the Company had asked for a maximum price of 24·2d.

Mr. *Valon* agreed, but recalled that when the inquiry was held new estimates were put forward, upon which a claim of 20d. was based. His figures showed that the net reduction in cost of supply since December, 1921, was 16·45d. per 1000 c.ft., equivalent to 3·58d. per therm. If, however, the decision of the Board of Trade to grant a maximum price of 19d. instead of 20d. was the result of an adjustment of the cost of supply shown in the Company's estimate, the net reduction in cost should be 2·58d.

Mr. *Evetts* disagreed with Mr. Valon's method of calculation. For instance, Mr. Valon's figure for net cost of coal was 20·42d. per 1000 c.ft., based on the quantities in the estimate submitted by the Company in 1921, but at present prices. His (Mr. Evetts') figure for the net cost of coal at present prices, based on 1927 results, was 25·23d. per 1000 c.ft. He added, in conclusion, that the Company was not keeping up the price of gas or the costs of repairs for fun. There was only one increase of charges over which the Directors had direct control, and that was in respect of the increased dividend; and the reason for that he had already explained.

Mr. *Valon*, in reply to questions, said he knew of no item in the accounts in respect of which costs should have increased for reasons outside the control of the Directors.

Mr. *Carpenter* said that if the Company were given another two years in which to put things right there would probably be a good case for revision then.

Mr. RONCA asked for further figures, which it was promised should be sent to him, and also intimated that he would defer the making of an Order for revision of the maximum price until he had had an opportunity of examining the 1928 accounts of the Company.

Mr. HILL emphasized that the Urban District Council had no desire to be unduly severe, but the public felt that the price of gas was high. He was bound to admit, at the same time, that recent examinations had indicated that the calorific value had been well maintained.

Mr. *Carpenter*, replying to questions with regard to the mains, said that their depth below the surface was not more than 8 or 9 in. in some cases. Traffic had increased greatly in volume, weight, and speed; nearly all the leakages had occurred on main roads where the cover was shallow, and the cast-iron mains were badly shaken, with the result that joints opened.

The inquiry then closed.

WINDSOR GAS-WORKS EXPLOSION.

Inquest on the late Mr. Herbert Buckley.

The inquest on Mr. Herbert Buckley, late Manager of the Windsor Gas-Works, who died in hospital from injuries he received in an explosion at the Windsor Gas-Works on Dec. 1, was held on Thursday last. Mr. H. Ryland, Coroner for the Borough, conducted the inquiry; Mr. E. C. Durant represented the Directors of the Company; and Mr. W. Turner, H.M. Inspector of Factories, represented the Home Office.

Mr. *John Gerald Abbott*, Acting Manager of the Company, said that just before the accident a new booster fan and governor had been erected in a small building at the gas-works; the object being to increase the pressure of gas to the Eton area.

William John Witcher, of Hammersmith, said he was an electrician in the employ of Messrs. Edwards & Co. The work in question was properly carried out. At 12.30 he switched the current on in the presence of Mr. Buckley and two other men, and the apparatus worked properly. The building in which the work was going on was about 12 ft. square. At one o'clock witness returned to the building, and Mr. Buckley asked him to start the booster again. There had been a smell of gas in the morning, but not exactly a strong smell. Before starting the apparatus again, he asked Mr. Buckley if it would be all right if there was a flash—meaning a flash from the electric switch. Mr. Buckley told him to start the fan, and afterwards to decrease the speed. As witness turned to do so, the explosion occurred. He saw no spark; and he had no views as to the cause. The smell of gas was not abnormal.

Henry Frank Gray said he was employed at the gas-works, and was one of the men working on the apparatus. He was down in the pit when Mr. Higley asked him to come up, as there was a strong smell of gas. Witness came up, and went to the door; and while he was there the explosion occurred. No one was smoking, and no one struck a light of any kind.

George Higley, a fitter employed by the Gas Company, said that after lunch on the day of the accident they again went through the process of opening and closing the valves which forced the air out of the pipes. After Mr. Buckley had told Mr. Witcher to start the booster, he heard Witcher say: "What about the spark." Mr. Buckley said it was all right, for they were only blowing air. There was a smell of gas. Mr. Witcher started the motor, and witness told Gray to come up from the pit, and stand on the planks. He heard Mr. Buckley tell Mr. Witcher to decrease the speed, and immediately afterwards there was a blinding flash and an explosion. His view was that the gas was ignited from a spark, probably from the switch or motor. Mr. Buckley had a cold; and he probably did not smell the gas so quickly as the others. Had witness been asked, he would have considered it safe to start the motor.

William Duckett, clerk at the gas-works, said that he saw Mr. Buckley in hospital after the accident, and he told witness that, just before the explosion, he had seen a spark from the starter.

Medical evidence showed that Mr. Buckley died from blood poisoning following severe burns.

The CORONER, having observed that the death of Mr. Buckley was a public loss to Windsor, said he thought the jury would come to the conclusion that death was accidental, and would probably not be able to state the cause of the accident. The apparatus was in good order; and though there was a smell of gas, the evidence had shown that it was the opinion of all witnesses that it was safe to work.

The jury returned a verdict of "Accidental death," and expressed sympathy with the widow.

Mr. DURANT, on behalf of the Directors of the Company, expressed to Mr. Buckley's family their deep regret and sympathy.

BRADFORD CORPORATION GAS DEPARTMENT.

Reduction in Price of Gas.

The Bradford Corporation Gas Department announce that as from the dates of the meter readings for the half-year ended Dec. 31, 1928, the price of gas for all purposes will be as follows.

The basic rates for gas consumed in one building will be:

Ordinary Meters.

—	Ordinary.		Industrial.	
	Per 1000.	Per Therm.	Per 1000.	Per Therm.
	At 500 B.Th.U. per C.Ft.			
	s. d.	d.	s. d.	d.
Within the city	3 9	9·0	3 2	7·6
Clayton, Wilsden, and Denholme . .	4 5	10·6	3 9	9·0
Scholes, Oakenshaw, Shelf, Hunsworth, and Clifton	4 7	11·0	3 9	9·0

Prepayment Meters.

The charge for gas supplied through prepayment meters for ordinary purposes will be increased by 7d. per 1000 c.ft., or 1·4d. per therm on the above rates.

The above prices relate to all gas consumed up to 10,000 c.ft. (50 therms) per half-year.

REBATES.

For consumptions over 10,000 c.ft. (50 therms) per half-year, rebates from the above rates will be made as shown under:

—	Ordinary.		Industrial.	
	Per 1000.	Per Therm.	Per 1000.	Per Therm.
	At 500 B.Th.U. per C.Ft.			
	s. d.	d.	s. d.	d.
For all gas consumed in excess of 10,000 c.ft. and up to 100,000 (500 therms) per half-year, a rebate of	0 5	1	0 4	0·8
For all gas consumed in excess of 100,000 c.ft. and up to 250,000 (1250 therms) per half-year, a rebate of .	0 7½	1½	0 6	1·2
For all gas consumed in excess of 250,000 c.ft. and up to 500,000 (2500 therms) per half-year, a rebate of .	0 10	2	0 8	1·6
For all gas consumed in excess of 500,000 c.ft. and up to 1,000,000 (5000 therms) per half-year, a rebate of .	1 0½	2½	0 10	2·0
For all gas consumed in excess of 1,000,000 c.ft. per half-year, a rebate of	1 3	3	1 0	2·4

The term "industrial" includes power and all strictly industrial purposes other than the lighting or heating of premises.

A discount of 5 p.ct. will be allowed for prompt payment of all accounts, except in the case of owners responsible for their tenants' accounts, who will be allowed 12½ p.ct. discount for prompt payment as heretofore.

METROPOLITAN GAS COMPANIES' OFFICIAL TESTINGS.

The Gas Referees' reports of the official testings for the past quarter give the following average calorific values for the gas supplied by the Metropolitan Companies named.

Commercial Gas Company.—502·2 B.Th.U. (declared calorific value, 500 B.Th.U.).

Gas Light and Coke Company.—561·7 B.Th.U. (declared calorific value, 500 B.Th.U.).

South Metropolitan Gas Company.—561·7 B.Th.U. (declared calorific value, 560 B.Th. U.).

South Suburban Gas Company.—503·7 B.Th.U. (declared calorific value, 500 B.Th.U.).

Tottenham and District Gas Company.—501·3 B.Th.U. (declared calorific value, 500 B.Th.U.).

Wandsworth, Wimbledon, and Epsom District Gas Company.—474 B.Th.U. (declared calorific value, 470 B.Th.U.).

PROGRESS AT LIVERPOOL.

Among a series of articles under the heading of "The Public Services" which appeared in a recent number of the "Liverpool Post," the progress of the gas industry in Liverpool was dealt with.

Some idea of the extent to which gas is utilized for domestic purposes in Liverpool, it was stated, may be gathered from the fact that the Liverpool Corporation has already had fixed on its various housing estates close on 40,000 gas fires, 20,000 gas cookers, and 20,000 gas wash-boilers. In addition, an unascertainable number of gas fires, cookers, &c., have been installed in subsidy and other houses erected by private builders.

The Gas Company itself is confronted with an ever-increasing demand for gas appliances. In the twelve months ended Dec. 31 last the Company entered on its books more than 6000 additional gas consumers. In the same period no fewer than 22,334 gas cookers were fixed by the Company on simple hire terms, and a further 784 cookers were sold, while as many as 6500 gas fires were installed. Nearly 600 radiators were fixed on simple hire during 1928. For these radiators on hire there is a growing call, admirably suited as they are for use in the halls and landings of dwelling houses as well as in shops.

With the object of assisting industry and promoting the use of smokeless fuel, the Gas Company has decided to extend the discounts allowed to large consumers (see "JOURNAL" for Jan. 16, p. 170).

CO-PARTNERSHIP DINNER AT LEA BRIDGE.

The success of the Lea Bridge Gas Company's Co-Partnership Scheme was very much in evidence at the second co-partnership dinner—attended by nearly 500 of the staff, employees, and their lady friends—held in the Recreation Hall of Messrs. Achille Serre, Ltd., Blackhorse Lane, Walthamstow, on the evening of Jan. 22.

The chair was occupied by Mr. A. M. PADDON, Chairman of the Company, supported by (among others) Mr. G. W. Carey (Director), Mr. S. H. Jones (Director), Mr. F. W. Cross (General Manager), Mr. D. C. Cross (Engineer), Mr. W. T. Kenshole (Assistant Engineer), Mr. D. J. Winslow (Distribution Superintendent), and Mr. H. Hand (Secretary).

The CHAIRMAN, having proposed the Loyal Toast, submitted the toast of the evening—"Success to their Co-Partnership." This, he said, was only the second occasion on which they had met in those circumstances; but a full seven years had passed since the co-partnership scheme was first introduced to their notice. He remembered well the circumstances of that appeal. It was then the duty of the Directorate to put it before them as a proposition and a policy, but they could not have had any definite feelings as to what the result would be, and they (the employees) could not have had a clear idea of what it would mean. Now that seven years had passed, he thought they realized in some degree what co-partnership meant, how high were its ideals, and how serious its aim. They did not aim at temporary gratification; they wanted to raise the whole of the circumstances of the workers. He felt he could say they had done this, though not perhaps to the full extent.

In the course of those few years they had provided for each co-partner, should he retire, be disabled, or be overtaken by death. Each had standing to his credit a little over £100. With only a few exceptions, he believed that, but for the scheme, they would not have had £10. It had done more than this, for it had brought home the fact that there was a close association between the Directors and the staff and employees of the undertaking. If they wanted something more to commend co-partnership, he would ask them to look round and observe the general industrial conditions of to-day. The steel, cotton, and coal industries were crumbling to-day, and he believed it was through lack of co-operation between the administrators and the workers, such as they had tried to stimulate. It showed clearly what co-partnership could yet achieve if they loyally and persistently supported it. So far the Directors were not disappointed with the result. It had fulfilled its purpose. It had been described as an endeavour to get the best out of the employees. If they could get the best out of a man, they were doing him the greatest service anyone could render. If they called forth the best, it would be better for those they worked with, better for those they worked for, and best of all for themselves.

COAL TRADE REPORTS.

From Our Own Correspondents.

NORTH-EAST COAST.

Markets remain good, and activity is maintained in practically all sections. Northumberland steams continue to enjoy excellent demand, and turns are well filled for some weeks ahead. In Durham coals, coking brands show the most improvement, and the demand for these is well maintained. Gas coals are reasonably active. Second-class qualities are certainly better placed than a few weeks ago, and bunkers maintain their recent improvement; best qualities being especially well booked.

Naturally, with the improved condition of current trading, buyers are beginning to look ahead, and inquiry for forward positions is increasing. There is, however, at present little prospect of any big advance in prices, as output is capable of being considerably expanded to meet additional requirements.

Quotations for gas coals remain unchanged for Wear Specials at 15s. 3d. to 15s. 6d. f.o.b., and 14s. 9d. for best qualities. Other qualities are 13s. 3d. to 14s.; and it cannot be said that gas could have participated to any great extent in the generally improved demand.

Coking coals have again been the feature, and outputs are fully booked for some weeks ahead at 14s. to 14s. 3d. for superior qualities, and 13s. 9d. for ordinaries. Best bunkers are strong at 14s. 3d. to 14s. 6d., and seconds are good at 13s. 9d. to 14s. Best Northumberland screened steams are 14s. 6d., and smalls are showing a welcome improvement.

Gas coke is in rather better demand; but ample stocks are still available. The quotation for shipment is 18s. 6d. to 18s. 9d. f.o.b.

YORKSHIRE AND LANCASHIRE.

Gas coals show an upward tendency owing to contracts being booked ahead of the usual period.

Industrial fuels are inclined to advance in value; washed varieties being in particular request.

Steam coals for export are in brisk demand. House coal is in moderate request, and recent prices are maintained.

The following are the Humber bunker and export prices, f.o.b. usual shipping ports:

South Yorkshire, Hards, Association, bunkers 19s. 9d. to 20s. 3d., export 16s. 6d.; screened gas coal, export 16s. 6d.; washed trebles, export 10s. to 16s. 6d.; washed doubles, bunkers 18s. 3d., export 15s. 3d. to 15s. 9d.; washed singles, export 14s. 6d. to 14s. 9d.; washed smalls, bunkers 14s. 9d., export 11s. to 11s. 6d.; rough slack, bunkers 12s. 6d. to 13s., export 8s. 6d. to 9s.; smithy peas, export 17s. to 17s. 6d.

West Yorkshire—Hartley's, bunkers 17s. 3d. to 17s. 9d., export 15s. to 15s. 6d.; screened gas coal, export 15s. to 15s. 6d.; washed trebles, export 15s. 6d. to 16s.; washed doubles, export 14s. 6d. to 14s. 9d.; washed singles, export 13s. 6d. to 14s.; washed smalls, bunkers 13s. 6d. to 14s., export 10s. 6d. to 11s.; unwashed trebles, export 15s.; unwashed doubles, export 12s. to 12s. 6d.; rough slack, export 9s. to 9s. 6d.

Derbyshire and Nottinghamshire—Top Hards, bunkers 19s. 9d. to 20s. 3d., export 16s. to 16s. 6d.; cobbles, export 15s. 6d. to 16s. 6d.; washed trebles, export 15s. 6d. to 16s.; washed doubles, export 14s. 6d. to 15s.; washed singles, export 14s. to 14s. 6d.; washed smalls, bunkers 14s. 9d., export 11s. to 11s. 6d.; unwashed doubles, export 12s. 6d. to 13s. 6d.; rough slack, bunkers 13s. to 13s. 6d., export 9s. to 9s. 6d.

Yorkshire, Derbyshire, and Nottinghamshire—Screened steam coal, bunkers 17s. 6d. to 18s., export 13s. to 14s.; gas coke, export 21s. to 25s.; furnace coke, export 19s. to 19s. 6d.; washed steam, Goole (West Yorks.), bunkers 17s. 6d., export 14s. 6d. to 15s.; Hull (West Yorks.), bunkers 18s., export 14s. 6d. to 15s.; Hull (South Yorks.), bunkers 18s., export 14s. 6d. to 15s.

MIDLANDS.

Some South Yorkshire colliery agents say they have made contracts for gas coal at an advance of 1s. to 2s. Sporadic increases of prices for other coals have been notified in various parts of the Midlands, both by associated and by independent collieries. There is no attempt at a general or uniform advance, the policy varying according to individual circumstances. Pressure for delivery has been accentuated in the house coal department. Outside collieries which cater largely for the domestic trade have had overflowing order books, and though they have been working at high pressure, they have not kept abreast of their engagements.

At not a few of the collieries owing allegiance to the Five-Counties Scheme the 62½ p.ct. quota was exhausted, or practically so, before the last week of January. Representations were made to headquarters that in view of the opportunity offered by the market of redressing some of the earlier losses the quota might be extended without any violence to the control. The response was not favourable, however.

The firmer tendency in slacks and smalls is maintained. Generally speaking, there is no difficulty in getting supplies, though delay is experienced where particular qualities of coal are specified, or where geographical limitations are imposed. The appreciation of prices is in many cases no more than a levelling-up. The average is put at about a shilling, but in regard to certain special coals which are never abundant, it is more. With market conditions disallowing a general advance, even in house coal, industrial qualities are practically unaffected. Coke supplies have not made much progress; blast-furnace qualities at South Yorkshire collieries being obtainable still at 13s. 6d. to 14s.

GAS REGULATION ACT APPLICATIONS.

DECLARATIONS OF CALORIFIC VALUE.

East Surrey Gas Company.—As from March 30, the gas which the Company intend to supply in the urban district of Dorking, the parishes of Abinger, Capel, Dorking Rural, Newdigate, Ockley, and Wootton, and so much of the parishes of Effingham and Mickleham and of Fetcham, Great Bookham, and Little Bookham, as is included in the limits of supply of the Company by the East Surrey Gas Order, 1928, shall have a calorific value of 450 B.Th.U.

TRADE NOTES.

Richmonds Gas Stove Company, Ltd.

This is the new name of the Richmond Gas Stove and Meter Company.

"Agate" Bathroom Suites.

Messrs. Saunders & Connor (Barrhead), Ltd., have recently published an attractively illustrated pamphlet dealing with their various manufactures in the shape of coloured porcelain enamelled bathroom and lavatory fittings. These fittings, including baths, basins, wall mirrors, &c., are produced in five different coloured enamels, and greatly enhance the decorative effect of the bathroom.

Varley's Patent Paracyclic Pump.

Messrs. Caldwell & Co. have issued a pamphlet dealing with the Varley patent paracyclic pump as manufactured by them. In this pump, with its paracyclic motion, the relative surface in contact between the displacer and the pump casing is very small as compared with that type of rotary pump in which the periphery of the rotor sweeps round the whole of the casing. The reduction gearing is housed in a separate chamber in the pump casing, no outside gearing being required.

New Plant for Birkenhead.

Messrs. Davison & Partner, Ltd., of Queen Anne's Gate, S.W. 1, have received an order from the County Borough of Birkenhead for the reconstruction of one of the 900,000 c.ft. carburetted water gas plants at the Corporation Gas-Works. The reconstructed unit will be hand-hydraulically operated, and have a capacity of 1,500,000 c.ft. daily. The contract includes an additional steam turbine-driven blowing set, electric platform coke hoist for feeding the generator, and patent "Centriflovane" grit catcher.

Tully Plants for Lerwick.

Messrs. Tully, Sons, & Co., Ltd., of Newark-on-Trent, have received an order from the Lerwick Gas Company, of Shetland, to remodel their gas undertaking throughout, by the installation of a duplicate set of the firm's latest coal gasification plant, each fitted with a waste-heat boiler and automatic mechanical operator complete; and also new purifiers, and a pressure-raising plant. The firm have been commissioned to overhaul the distribution system, with the object of supplying 380 to 400 B.Th.U. gas.

Renold Stock Chain Drives.

Hans Renold, Ltd., Burnage Works, Didsbury, Manchester, have just published the 1929 edition of their booklet "Renold Stock Chain Drives." Consequent upon increased production since the introduction of this stock series, considerable reductions have been possible both in the prices of the drives, and in the reboring and keywaying charges. A new design of plate wheel adaptors has been produced to meet the requirements of machines where a range of varying speeds is required, and quick change is essential.

Celite Products Corporation.

Celite Products Corporation, New York, have issued two bulletins, Nos. 102 and 340, dealing with heat insulation in the smelting and refining of non-ferrous metals, and quality concrete for every kind of structure. The advantages of their "Sil-O-Cel" insulation, they claim, include reduced fuel costs, more accurate temperature control, more uniform heat distribution, and general increase in simplicity of operation. The Corporation's "Celite" material is a finely-ground mineral powder composed of practically pure amorphous silica. It is added to a concrete mixture with the other dry materials at the mixer, in quantities of from 2 to 6 lbs. per bag of portland cement, depending on the mix and character of the aggregates. The functions of "Celite" in a concrete mixture are to increase its workability without the use of excess water, to prevent segregation, to ensure uniformity and water-tightness and improve the finish and the quality of the final concrete.

CONTRACTS OPEN.

Mantles.

The Stoke-on-Trent Gas Department invite tenders for mantles, &c. [See advert. on p. 303.]

General Stores, Oils, Ironmongery, &c.

The Stoke-on-Trent Gas Department invite tenders for general stores, materials, &c. [See advert. on p. 303.]

Tubes and Fittings.

The Stoke-on-Trent Gas Department invite tenders for, among other stores, tubes and fittings. [See advert. on p. 303.]

Gasholder.

The Corporation of Nottingham invite tenders for the supply and erection of a 5 million c.ft. gasholder (waterless or spiral guided). [See advert. on p. 303.]

Vertical Retorts, &c.

The Maryport Gas Department invite tenders for the installation of vertical retorts, including steam exhausting plant, boilers, &c. [See advert. on p. 303.]

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Jan.* 28.

Business in tar products still continues quiet, and current values are as follows:

Pitch, about 37s. 6d. per ton.

Creosote, about 7d. per gallon.

Pure benzole, 1s. 9d. to 1s. 10d. per gallon; pure toluole, about 2s. per gallon; 95/160 solvent naphtha, 1s. 5d. to 1s. 6d. per gallon.

Pyridine, about 4s. 3d. per gallon.

Tar Products in the Provinces.

Jan. 28.

Generally speaking, markets for tar products remain unchanged. There is little or no variation in prices.

The average prices of gas-works products during the week were: Gas-works tar, 22s. 6d. to 27s. 6d. Pitch—East Coast, 35s. to 36s. f.o.b. West Coast—Manchester, 30s. to 30s. 6d.; Liverpool, 32s. to 33s.; Clyde, 32s. to 33s. Toluole, naked, North, 1s. 5d. to 1s. 6d. nominal. Coal-tar crude naphtha, in bulk, North, 9d to 10d. Solvent naphtha, naked, North, 1s. 1½d. to 1s. 2d. Heavy naphtha, North, 1s. to 1s. 0½d. Creosote, in bulk, North, liquid, 4⅝d. to 4¾d.; salty, 4½d. to 4⅝d.; Scotland, 4½d. to 4⅝d. Heavy oils, in bulk, North, 8¼d. to 8½d. Carbolic acid, 60 p.ct., 1s. 10d. to 1s. 11d. prompt. Naphthalene, £13 to £15; salts, £5 to £5 10s., bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

Benzole Prices.

The following are considered to be the market prices to-day:

	s. d.		s. d.	
Crude benzole . . .	0 10	to	0 10½	per gallon at works
Motor ,, . . .	1 4	,,	1 4½	,, ,, ,,
90 p.ct. ,, . . .	1 7	,,	1 8	,, ,, ,,
Pure ,, . . .	1 10	,,	1 11	,, ,, ,,

Gas for Preston Tenants.—Following a letter from the Preston Gas Company regarding forty-two "all-electric" houses now being erected at Holme Slack, the Preston Housing Committee have agreed to the laying of pipes for those tenants who require gas.

Gas Light and Coke Company's Dividend.—The accounts of the Company for the past year show that the balance to the credit of the net revenue account will enable the Directors to recommend the payment of dividends for the half-year to Dec. 31 last as follows: On the 4 p.ct. consolidated preference stock, at the rate of 4 p.ct. per annum; on the 3½ p.ct. maximum stock, at the rate of 3½ p.ct. per annum; and on the ordinary stock, at the rate of £5 12s. p.ct. per annum, carrying forward to the next account the sum of £158,657 16s. 10d.

Proposed Insurance Scheme at Accrington.—An unusual form of insurance being considered by the Accrington District Gas Board provides against loss by the theft of money transferred either from the bank to the office (or *vice versa*), or from slot meters to the office, and so on. The Clerk of the Board said the premium quoted, based on a total collection of £394,000 a year, was £33 9s. 3d. He said money might be taken from perfectly honest employees who might be knocked down in the street. The Board adjourned the matter for consideration by the General Manager, Mr. A. J. Harrison.

A Spherical Gasholder for Skipton?—The possibilities of a steel spherical gasholder for Skipton were considered by the Urban District Council of that town, recently, in a discussion on a new gasholder which it is proposed to erect on land near Carleton Road, but in regard to which there is active opposition by residents. The Clerk said that, if the Council decided to promote a Special Order, it would rest with the Board of Trade to decide between the interests of the gas undertaking and the objectors. The Gas Committee had considered the question of type of holder, with a view to meeting the objections, and had instructed the Gas Manager to obtain further information as to the steel spherical holders being extensively erected in America and Canada. The Council approved the Gas Committee's instruction.

Sir Arbuthnot Lane and Gas Fires.—In an article in the December issue of "New Health," Sir Arbuthnot Lane, Bart., C.B., President of the New Health Society, says: "The gas fire keeps the air at any temperature desired, since the degree of heat it gives out can be regulated with great simplicity. It ventilates the air of the room even more perfectly than a coal fire, as the air not only passes up the chimney above the fire, but it is drawn through the incandescent material as well. It does not dry the air of the room, and consequently exerts no prejudicial influence on the growth of plants or flowers contained in it. Above all, it leaves no deposit of smoke or dust to endanger health, and soil pictures, furniture, wallpaper, and ceiling." The foregoing appeared as an advertisement for the Liverpool Gas Company in a recent issue of the "Liverpool Post."

Cheaper Gas for Walsall.—Reductions in the gas charges operating from the December reading of the meters were announced by the Gas Committee at a meeting of the Walsall Town Council recently. The reductions are as follows: Slot meter consumers using up to 3000 c.ft. for summer quarters and 4500 c.ft. for winter quarters, from 12¼d. per therm to 12d. per therm. For all other consumers, including power consumers, the cash discount will be abolished, and the following revised charges made: For the first 5000 c.ft. per quarter in all cases, 10½d. per therm; up to 10,000 c.ft., 9½d. per therm; up to 25,000 c.ft., 9¼d. per therm; up to 35,000 c.ft., 9d. per therm; up to 55,000 c.ft., 8⅞d. per therm; up to 75,000 c.ft., 8½d. per therm; up to 95,000 c.ft., 8¼d. per therm; up to 145,000 c.ft., 8d. per therm; up to 195,000 c.ft. 7⅞d. per therm; up to 295,000 c.ft., 7¼d. per therm; and 300,000 c.ft. and over, 6¼d. per therm.

Oswaldtwistle Re-Assessment Appeal.—The Oswaldtwistle District Council have lodged an appeal against the new assessment of the local gas-works, and have decided that a preliminary report on the assessment be obtained from a London firm.

Hull Gas Profits.—During the past twelve months the Hull Corporation have made a profit of £1280 out of gas. The gas is bought in bulk, and sold to the consumers living in the old quarter of the town, where the Corporation have never surrendered the right of supply which they held in the earliest days of artificial illumination.

Aldershot Stock Issue.—The tenders which were offered by Messrs. A. & W. Richards, of 37, Walbrook, E.C. 4, on behalf of the Directors of the Aldershot Gas, Water, and District Lighting Company (see "JOURNAL" for Jan. 16, p. 172), were opened on Jan. 23. For the £110,000 stock offered, tenders were sent in for £300,500, ranging from £80 down to the minimum of £70, the average price obtained for the issue being £71 15s. 2d. p.ct.

New Gas Drying Plant for Tottenham Company.—The Tottenham District Gas Company have placed a contract for a gas washing and drying plant, which is to be erected at their Ponders End Works. This is in addition to the plant now in course of erection at their main station. The plant at Tottenham will be one of the largest of its kind, capable of washing and drying 16 million c.ft. of gas daily; while that at Ponders End will deal with 3 million c.ft. daily.

Liquidation of Tully Gas Plants (1927), Ltd.—The first annual meeting of Tully Gas Plants (1927), Ltd., was held in London on Jan. 22. The Company has not commenced business, so there were no accounts available. Colonel W. A. Bristowe, presiding, said it was found that the entire capital had been credited as fully paid and issued, so that no new cash was brought into it, while the only assets were a string of patents and an agreement with a firm in Paris. He had gone very carefully into the question of the value of the patents, and he did not advise the shareholders to put any more money into the Company. Colonel Wilson proposed the voluntary winding up of the Company, and Colonel Thorp seconded. The motion was carried unanimously.

Reduction in Price at Congleton.—The Congleton Gas Committee have decided to reduce the price of gas by 3d. per 1000 c.ft. for all purposes as from Jan. 1. This reduction, it was stated by the Gas Manager, Mr. W. A. Cartlidge, would make the price 1d. per 1000 c.ft. less than that charged for power and industrial purposes before the war. Referring to the estimated income and expenditure at the gas-works for the year ending March 31, 1929, Mr. Cartlidge estimated the net profit, if nothing unusual occurred, at £1300. In arriving at this figure, certain reservations had to be made in regard to extra work which would have to be done during the coming year on the revenue account. There would also be an increase in the rates on the works of £650 under the new assessment.

Service Troubles at Accrington.—Troubles of the Accrington District Gas Board with their gas supply, which now comes from pit-head coke ovens under contract with a colliery company, were the subject of a report by the General Manager, Mr. A. J. Harrison, on Jan. 24. Mr. Harrison said tests for naphthalene were carried out from the commencement. Slight traces began to appear about Oct. 24. The colliery were informed and were convinced by the Board that the trouble was serious. The colliery were afraid the washing plant installed was too small. The Board secured a washer to assist in keeping down the trouble until the colliery got their new plant into service. There were other important points. Unless the Board had taken the supply of gas the probability was that this particular colliery would have had to dispense with a large number of miners. It was not generally understood that the greater part of the trouble of insufficient supply was due to pipes originally laid down by contractors, property owners, or tenants. Relics of old service pipes still in use had accentuated the evil. The number of services laid to new property, and new services laid to replace defective services to old property, approximated 7500 since April, 1924; and 927 old connections had been cut off. There were blocks of property with defective supplies, where the Department was unable to effect an improvement, because the owner and sometimes the tenant would not sanction the opening up of the ground through which the old pipes ran. Fully 90 p.ct. of the complaints recently received were from property supplied with these old pipes. No consumer was without a supply where the service had been re-laid since April, 1924, neither had a single complaint been received from the Whalley district. Naphthalene trouble had occurred in some of the new connections, but was very easily cleared. The supply pipes requiring renewal exceeded 1000, and gangs had been strengthened to cope wtih the work. The Board could accept no responsibility for defective pipes.

Re-Assessment at Port Talbot.—The Mayor of Port Talbot (Alderman Dummer), presiding over the monthly meeting of the Port Talbot Gas and Electricity Committee on Jan. 9, expressed his dissatisfaction at the revaluation of the gas-works. The valuer, in arriving at their re-assessment under the Rating and Valuation Act, had increased the figure from £740 to £2500, which was characterized by members as "absurd and unjustifiable." The Gas Manager, Mr. A. J. Bond, intimated that he would appeal.

Hoxton Gas Tragedy Inquest.—A verdict of "Accidental death" was returned at the conclusion of the inquest on Jan. 22 on Mrs. Martha Grey (41), of Holt Place, Hoxton, the victim of an escape of gas from a fractured main in Holt Place a fortnight ago, in which twenty other persons were affected (see "JOURNAL" for Jan. 16, p. 171). The inquest was conducted by Dr. E. Smith, the North-East London Coroner. Mr. H. J. Escreet, Assistant Distributing Engineer to the Gas Light and Coke Company, said that it was subsequently found that the 3-in. main was fractured at the junction with the service pipe from the premises where deceased was found. He thought that the gas filled up the space beneath the concrete roadway, and percolated through the foundation of the house. The pipe was fifty years old, and the fracture, he thought, might have been due to the frost, though vibration due to traffic might have been a contributory cause. The main was last tested in 1925. Unless the road was pulled up by the Borough Council, or there was a breakage, the mains were not examined.

We have received from Messrs. W. G. Beaumont & Son, of Priory Works, Bow, E., a tastefully-designed calendar.

From King's Patent Agency, Ltd., of 146A, Queen Victoria Street, E.C. 4, we have received a useful pocket diary, with one day on a page.

According to the Chief Constable of Middlesbrough, thefts of money from gas meters have been unusually prevalent recently in the poorer quarters of that town.

The Town Clerk of Omagh (Co. Tyrone) has been directed to obtain legal opinion on the Council's powers under their Gas Act, with a view to supplying the town with electricity.

The Wimborne Minster Gas Company, Ltd., have issued to their consumers an attractive calendar with a view to keeping the uses for gas prominently before the public eye during the coming year.

At the Ship Hotel, Rotherham, on Jan. 14, an electric wire fused, and melted a gas pipe, igniting the gas, and setting alight a floor beam in the cellar of the hotel. The heat from the beam, however, melted the drawpipes from some beer barrels, and the beer thus released kept the fire under control until the arrival of the brigade.

Two of six victims of a gas accident at Newcastle-upon-Tyne early in the morning of Jan. 17, died in the Newcastle Infirmary last Saturday. With four other persons in an adjoining house they were found unconscious in bed, as a result of escaping gas percolating into the premises from a fractured main in the road. They did not regain consciousness.

The fifth edition of the Auctioneers' Press Guide is now on sale. The list of over 1000 newspapers and periodicals issued in Great Britain with particulars of charges for the insertion of property advertisements and other details necessary to the Auctioneer has been thoroughly revised. Improvements include the addition of telephone numbers and the latest time that copy should be put in the hands of the various newspapers. Copies, price 2s., may be obtained from the publishers, 5, Clements Inn, London, W.C. 2.

At the inquest on Anne Jane Kane, the victim of gas poisoning in Norton Street, Belfast, the Coroner praised the officials of the Belfast Gas Department for the prompt and efficient way in which they had handled the escape. Mr. T. J. M'Keown, Solicitor for the Corporation, said that the City Hall were informed of the escape at 11.10 a.m. on Jan. 8. By 11.25 a gas inspector was on the spot, and before 11.40 a squad were at work in Norton Street. The thick cast-iron main was found to be cleanly broken, and, except for the fracture, was in perfect condition. It was thought that the subsidence of the subsoil was responsible for a great strain being put upon the pipe. The vibration of the traffic eventually caused it to snap. The event could not have been foreseen. A verdict of "Accidental death" was returned.

"Competition Points for Gas Salesmen."

SECOND EDITION.

Revised and Brought up to date.

Written and Compiled by

A. F. Bezant and N. S. Smith, B.Sc.

Price **7/6**, post free.

LONDON: WALTER KING, LTD., 11, BOLT COURT, FLEET STREET, E.C. 4.

STOCK AND SHARE LIST.

[For Stock Market Report, see earlier pages.]

Issue.	Share.	When ex-Dividend.	Dividends. Prev. Hf.Yr	Dividends. Last Hf. Yr.	NAME.	Quotations. Jan. 25.	Rise or Fall on Week.	Transactions Lowest and Highest Prices.
£			% p.a.	% p.a.				
171,978	Stk.	Aug 30	5	5	Aldershot 5 p.c. max. C. .	72—77	..	..
412,992	,,	,,	4	4	Do. 4 p.c. Pref. . .	73—76	+4	72—74½
1,551,868	,,	Sept. 27	7	7½	Alliance & Dublin Ord. .	99—102	+1	99—101
374,000	,,	Jan. 10	4	4	Do. 4 p.c. Deb. . .	63—65	..	..
522,654	,,	Aug. 30	7	7	Barnet Ord. 7 p.c. . .	114—117	..	..
300,000	1	Oct. 11	1/7½	1/4½	Bombay, Ltd.	20/—22/-	..	21/6
170,000	10	Aug. 30	8½	8½	Bournemouth 5 p.c. . . .	12½—13½	..	..
500,050	10	,,	7	7	Do. B 7 p.c. . .	12½—13	..	12⅝—12⅞
375,000	10	,,	6	6	Do. Pref. 6 p.c. .	11—11½	..	..
50,000	Stk.	Jan. 10	3	3	Do. 5 p.c. Deb. .	55—58	..	..
162,025	,,	,,	4	4	Do. 4 p.c. Deb. .	74—77	..	..
357,900	,,	Aug. 30	7½	7½	Brighton & Hove 6 p.c. Con.	116—118	..	..
341,880	,,	,,	6½	6½	Do. 5 p.c. Con.	101—104	..	103½
1,287,500	,,	July 26	5	5	Bristol 5 p.c. max. . . .	93½—94½a	..	..
855,000	,,	Sept. 27	7	8	British Ord.	115—118	..	116½—117
100,000	,,	Dec. 10	7	7	Do. 7 p.c. Pref. . .	115—120	..	..
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. .	73—76	..	..
200,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. .	93—96	..	..
100,000	10	Dec. 6	8	6	Cape Town, Ltd. . . .	8—9	..	..
100,000	10	Oct 25	4½	4½	Do. 4½ p.c. Pref. . .	6¾—7½	..	..
150,000	Stk.	Dec. 20	4½	4½	Do. 4½ p.c. Deb. . .	71—76	..	..
626,860	,,	July 26	6	6	Cardiff Con. Ord. . . .	97—100	..	..
287,850	,,	Jan. 10	7½	7½	Do. 7½ p.c. Red. Deb. .	98—101	..	..
157,150	,,	Aug. 16	5½	5	Chester 5 p.c. Ord. . . .	89—94b	..	..
79,185	1	Oct. 11	12/-	12/-	Colombo Ltd. Ord. . . .	36/—38/-	..	37/3
24,495	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. .	21/—23/-	..	..
375,402	1	Oct. 11	1/9½	1/9½	Colonial Gas Assn. Ld. Ord	24/6—26/6	+/6	..
187,848	1	,,	1/7½	1/7½	Do. 8 p.c. Pref.	21/—23/-	..	..
2,073,280	Stk.	July 26	7	5	Commercial Ord. . . .	99—102	+1	100½—100⅝
475,000	,,	Dec. 20	8	8	Do 8 p.c. Deb. .	56—59	..	60½
800,000	,,	Sept. 27	11	11	Continental Union, Ltd. .	122—127	−4½	123—128
200,000	,,	,,	7	7	Do. 7 p.c. Pref. .	122—127	−1	126—129
787,560	,,	Aug. 16	7	7	Croydon sliding scale . .	111—114	+1	..
409,100	,,	,,	5	5	Do. max. div. . . .	84—87	..	86
492,270	,,	Aug. 16	10	7	Derby Con.	115—120e	..	..
55,000	,,	Dec. 20	4	4	Do. Deb.	70—72e	..	..
309,000	,,	Aug. 30	5	5	East Hull Ord. 5 p.c. . .	75—78	..	..
1,002,180	10	Sept. 13	16	14	European, Ltd.	11 12	..	11⅞—11⅝
18,703,480	Stk.	July 26	5/1¼	5½	Gas Light & Coke 4 p.c. Ord.	19/3—19/9f	+/3	19/-—19/9
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max. . . .	65—67	+1	64⅜—65½
4,157,020	,,	,,	4	4	Do. 4 p.c. Con. Pref. .	79—82	..	79½—81
5,602,620	,,	Dec. 20	3	3	Do. 3 p.c. Con. Deb. .	59—61	..	59½—60½
181,315	,,	,,	6	6	Do. 6 p.c. Br'tf'd Rd. Db.	102—105	..	..
1,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. .	98—101	..	101
42,000	,,	—	7½	7½	Do. 7½ p.c. Ilford Deb. .	..	..	..
82,500	,,	Aug. 30	6⅔	7	Hastings & St L. 5 p.c. Conv	95—100	..	..
238,740	,,	,,	5⅔	5⅔	Do. 3½ p.c. Conv.	75—80	..	..
70,000	10	Oct. 11	†10	†10	Hongkong & China, Ltd. .	13—14	..	..
173,200	Stk.	Aug. 30	5	5½	Hornsey Con. 3½ p.c. . .	88—91	..	..
1,976,000	,,	Nov. 8	10	10	Imperial Continental Cap.	275—285	..	271—284
223,130	,,	Aug 16	3½	3½	Do. 3½ p.c. Red. Deb.	68—70	+1	..
235,242	,,	Aug. 16	7	7½	Lea Bridge 5 p.c. Ord. . .	120—123	+3	121—122
2,145,907	,,	Aug. 16	5½	5½	Liverpool 5 p.c. Ord. . .	91—92b	+¾	..
600,000	,,	Sept 27	7	7	Do. 7 p.c. Red. Pref.	101—103b	..	..
165,736	,,	Aug. 16	8	9	Maidstone 5 p.c. Cap. . .	124—129	..	..
63,480	,,	Dec. 20	3	3	Do. 3 p.c. Deb. . .	54—57	..	..
75,000	5	Dec. 6	†8	†8	Malta & Mediterranean .	5½—6	..	5 11/16
392,000	—	—	—	—	Metrop'tan (of Melbourne) 5½ p.c. Red. Deb. . . .	100—102	+1	..
641,920	Stk.	Nov. 22	†7	†5	Montevideo, Ltd. . . .	97—100	..	..
2,051,315	,,	Aug. 16	5	5	Newcastle & Gateshead Con.	17/3—17/9df	..	..
360,929	,,	,,	4	4	Do. 4 p.c. Pref. .	73½—74½d	..	..
691,705	,,	Dec. 20	8½	8½	Do. 8½ p.c. Deb. .	68—69d	..	..
131,780	,,	Aug. 30	6/18/0	7/1/0	North Middlesex 6 p.c. Con.	102—107	..	105
300,000	,,	Nov. 22	7	9	Oriental, Ltd.	113—116	+1	115½
188,120	,,	Dec. 20	7½	8	Plym'th & Ston'house 5 p.c.	108—111	..	..
414,500	,,	Aug. 30	7½	7½	Portsm'th Con. Stk. 4p.c. Std.	109—112	..	..
236,732	,,	,,	5	5	Do. 5 p.c. max.	80—83	..	..
2,334,464	1	—	—	—	Primitiva Ord.	26/—28/-	..	26/6—27/4½
244,500	100	Dec. 8	4	4	Do. 4 p.c. Red. Deb. . .	91—94	..	..
695,000	Stk.	Jan. 24	4	4	Do. 4 p.c. Red. Deb. 1911	78—80*	−1	80
416,345	,,	Dec. 20	4	4	Do. 4 p.c. Cons. Deb. . .	78—80	..	..
150,000	10	Sept. 27	6	6	San Paulo 6 p.c. Pref. . .	8⅞—8⅞	..	..
1,736,968	Stk.	Aug. 30	—	—	Sheffield Cons.	104—106e	..	..
95,000	,,	Jan 10	—	—	Do. 4 p.c. Deb. . . .	73—75e	..	..
90,000	10	June 14	‡3	‡4	South African	4—6	..	..
6,609,895	Stk.	July 26	7½	5	South Met. Ord.	107—109	+½	107½—109
500,000	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	110—113	..	..
1,895,445	,,	Jan. 10	8	8	Do. 8 p.c. Deb. . .	59—61	..	60—61
784,000	,,	Sept 13	6½	6½	Do. 6½ p.c. Red. Db.	101—103	..	..
91,500	,,	Aug. 16	8½	8½	South Shields Con. . . .	109—110d	..	..
1,243,795	,,	July 26	6½	6½	South Suburban Ord. 5 p.c.	109—112	..	109—110½
868,887	,,	Dec. 20	5	5	Do. 5 p.c. Deb.	98—101	+1	99—100
647,740	,,	Aug. 30	5	5	South'mpton Ord. 5 p.c. max.	77—79	..	..
121,275	,,	Dec. 20	4	4	Do. 4 p.c. Deb.	72—75	..	..
250,000	,,	Aug 30	7	7	Swansea 7 p.c. Red. Pref. .	101—103	..	..
300,000	,,	Dec. 20	6½	6½	Do. 6½ p.c. Red. Deb.	99—101	..	..
1,002,275	,,	—	—	—	Tottenham District Ord. .	101—104	..	102⅞—103½
150,000	,,	July 29	5½	5½	Do. 5½ p.c. Pref.	96—99	..	..
181,255	,,	Dec. 6	4	4	Do. 4 p.c. Deb.	75—78	..	..
289,094	,,	Aug. 30	5 7/16	5⅞	Uxbridge, Maidenhead, & Wycombe 5 p.c. . . .	93—98	..	..
88,380	,,	,,	5	5	Do. 5 p.c. pref. .	87—92	..	..
80,000	,,	July 12	8½	8½	Wandsworth, Wimbledon, and Epsom— Wandsworth A 5 p.c. .	130—135	..	..
256,836	,,	,,	7	7½	Do. B 8½ p.c. .	115—120	..	115½
432,585	,,	,,	5/19/0	6½	Do. C and New	99—104	..	..
352,000	,,	,,	6⅝	6⅞	Do. Wimbledon 5 p.c. .	107—112	..	..
98,000	,,	,,	7⅛	7⅛	Do. Epsom 5 p.c. . .	117—122	..	..
200,000	,,	,,	5	5	Do. 5 p.c. Pref . . .	90—95	+3	93—94
88,416	,,	Dec. 20	3	3	Do. 3 p.c. Deb. . . .	57—60	+1	..
284,743	,,	,,	4	4	Do. 4 p.c. Deb. . . .	77—80	+2	..
207,500	,,	,,	5	5	Do. 5 p.c. Deb. . . .	97—100	+1½	..

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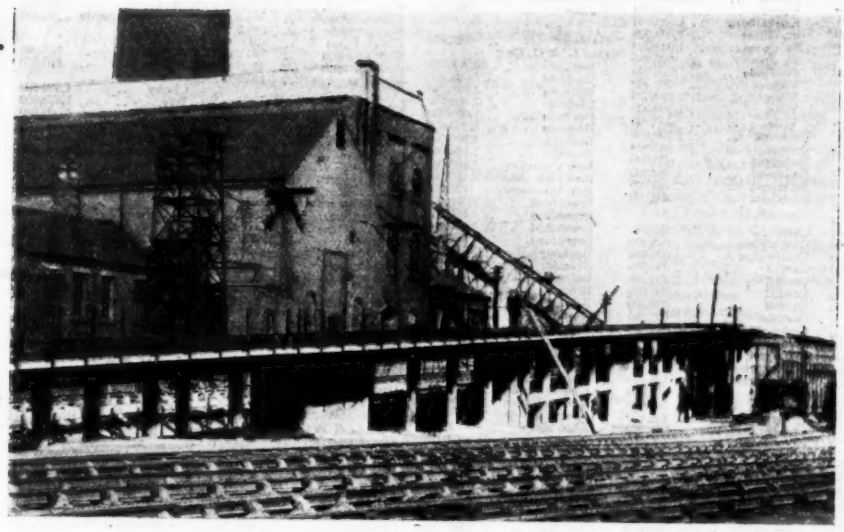

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Falmouth	150,000
Faversham	200,000
Flensburg	300,000
Flensburg	125,000
Forst	300,000
Frankenthal	175,000
Fuel Research Wks.	500,000
Fuel Research Wks.	500,000
Furnes	900,000
Gabions	140,000
Gas L. & C. Co.:	
Beckton	10,000,000
Beckton	7,000,000
Beckton	3,500,000
Beckton	7,000,000
Beckton	7,000,000
Beckton	5,250,000
Beckton	4,800,000
Beckton	3,000,000
Bow Common	1,000,000
Bow Common	1,150,000
Bow Common	150,000
Brentford	1,300,000
Brentford	350,000
Brentford	350,000
Brentford	750,000
Bromley	3,750,000
Bromley	2,250,000
Bromley	1,000,000
Bromley	1,000,000
Bromley	1,000,000
Bromley	1,450,000
Bromley	1,350,000
Fulham	2,500,000
Fulham	1,700,000
Ilford	650,000
Ilford	750,000
Kensal Green	2,250,000
Kensal Green	2,250,000
Kensal Green	2,250,000
Nine Elms	2,750,000
Nine Elms	750,000
Nine Elms	1,870,000
Nine Elms	2,850,000
Shoreditch	900,000
Shoreditch	2,700,000
Shoreditch	2,725,000
Southall	2,000,000
Southall	3,000,000
Staines	600,000
Stratford	1,700,000
Stratford	850,000
Stratford	2,350,000
Stratford	2,350,000
Gelsenkirchen	175,000
Gelsenkirchen	350,000
Geneva	500,000
Geneva	700,000
Gennevilliers	10,600,000
Gennevilliers	2,900,000
Girvan	235,000
Glasgow	3,000,000
Glasgow	2,500,000
Glasgow	2,250,000
Glossop	340,000
Gloucester	800,000
Gloucester	1,000,000
Gosport	200,000
Gosport	225,000
Göteborg	300,000
Göteborg	600,000
Grackenz	200,000
Grays	250,000
Grays	400,000
Groningen, Holland	500,000
Guest Keen & Piggotts, Ltd.	1,936,000
Guildford	350,000
Guildford	200,000
Guildford	350,000
Guildford	1,100,000
Guildford	150,000
Haarlem	850,000
Hamburg	1,750,000
Hampton Court	500,000
Hampton Court	600,000
Hampton Court	1,100,000
Hanley	800,000
Hanley	800,000
Hartlepool	750,000
Hartlepool	765,000
Haywards Heath	470,000
Hebden Bridge	200,000
Heidelberg	200,000
Hereford	525,000
Hertford	197,000
Hertford	244,000
Hessle	150,000
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Hilversum	850,000
Hinckley	250,000
Holyhead	197,000
Hong Kong	450,000
Hong Kong	450,000
Hornsey	1,000,000
Hornsey	1,000,000
Hornsey	750,000
Hornsey	750,000
Horsham	235,000
Hull	1,500,000
Hull	1,000,000
Hull	1,600,000
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Ipswich	1,250,000
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Karlsbad	350,000
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Lausanne	385,000
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Lea Bridge	350,000
Lea Bridge	400,000
Lea Bridge	1,000,000
Lea Bridge	1,500,000
Lea Bridge	1,530,000
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Leamington	525,000
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Leeuwarden	400,000
Leiden	500,000
Leiden	575,000
Leigh	350,000
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Lemberg	500,000
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Letchworth	423,000
Liége	1,000,000
Liége	750,000
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Lincoln	500,000
Lincoln	893,000
Liverpool	3,500,000
Liverpool	4,500,000
Liverpool	750,000
Liverpool	1,750,000
Liverpool	1,250,000
Liverpool	3,000,000
Liverpool	1,500,000
Liverpool	1,250,000
Liverpool	2,350,000
Long Eaton	430,000
Long Eaton	170,000
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Luton	400,000
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Magdeburg	1,400,000
Maidenhead	225,000
Maidenhead	225,000
Maidenhead	175,000
Maidenhead	175,000
Maidstone	500,000
Maidstone	500,000
Malines	500,000
Malines	575,000
Malmö	350,000
Malta	400,000
Manchester	3,500,000
Manchester	3,500,000
Manchester	1,500,000
Mansfield	330,000
Mansfield	433,000
Marlborough	100,000
Mayence	700,000
Melbourne	5,000,000
Merthyr Tydfil	300,000
Merthyr Tydfil	200,000
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Newcastle, N.S.W.	500,000
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Niotheroy	250,000
N. Middlesex	150,000
N. Middlesex	200,000
N. Middlesex	75,000
N. Middlesex	650,000
N. Middlesex	650,000
N. Middlesex	1,000,000
Northfleet	235,000
North Sydney	500,000
North Sydney	500,000
Norwich	1,000,000
Norwich	300,000
Norwich	500,000
Norwich	1,500,000
Nottingham	1,000,000
Nottingham	1,000,000
Nuneaton	125,000
Oberhausen	175,000
Oldbury	500,000
Oldenburg	300,000
Ormskirk	170,000
Ostend	100,000
Ostend	200,000
" Zandvoorde	700,000
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Palermo	850,000
Paris:	
Clichy	4,000,000
Ivry	1,576,000
Landy	6,000,000
Landy	6,000,000
La Villette	4,000,000
La Villette	2,000,000
St. Mandé	1,570,000
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Pontypool	120,000
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Portsmouth	1,000,000
Portsmouth	2,000,000
Portsmouth	800,000
Portsmouth	2,000,000
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Posen	700,000
Prague	140,000
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Reading	1,000,000
Reading	600,000
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Redhill	275,000
Redhill	300,000
Redhill	1,100,000
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Reichenberg	200,000
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Romford	350,000
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Rotterdam	750,000
Rotterdam	750,000
Rotterdam	600,000
Rotterdam	2,000,000
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St. Gallen	225,000
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Scarborough	800,000
Scarborough	200,000
Scarborough	350,000
Scarborough	1,300,000
Scarborough	1,350,000
Seaford	200,000
Shanghai	225,000
Shanghai	225,000
Shanghai	1,600,000
Shanklin	259,000
Sheerness	200,000
Sheerness	180,000
Sheerness	200,000
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" Steel Prods.	5,000,000
Shrewsbury	300,000
Sidmouth	225,000
Sittingbourne	259,000
Southampton	800,000
Southampton	500,000
Southampton	600,000
Southampton	100,000
Southampton	1,000,000
Southend	1,250,000
Southend	900,000
Southend	900,000
Southgate	400,000
Southgate	500,000
Southgate	800,000
Southgate	500,000
Southport	750,000
Southport	900,000
Southport	900,000
Southport	450,000
South Shields	650,000
South Shields	1,250,000
Stafford	500,000
Stettin	880,000
Stirling	400,000
Stockholm	1,500,000
Stockholm	1,750,000
Stockport	600,000
Stockport	600,000
Stockport	400,000
Stockport	400,000
Stockton	500,000
Stockton	250,000
Stourbridge	500,000
Stourbridge	500,000
Sunderland	2,250,000
Sunderland	300,000
Sutton	1,269,000
Swansea	750,000
Swansea	1,000,000
Swansea	450,000
Swansea	1,250,000
Swansea	2,000,000
Swinden	300,000
Swindon	470,000
Swindon	400,000
Sydney	1,000,000
Sydney	1,000,000
Sydney	1,000,000
Sydney	1,000,000
Sydney	8,250,000
Taunton	225,000
Taunton	350,000
Tawe Valley	275,000
Teignmouth	200,000
The Hague	1,000,000
The Hague	500,000
The Hague	1,750,000
The Hague	1,500,000
The Hague	775,000
The Hague	1,500,000
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Tirlemont	120,000
Tokyo	2,000,000
Torquay	350,000
Torquay	350,000
Torquay	320,000
Tottenham	750,000
Tottenham	750,000
Tottenham	350,000
Tottenham	1,000,000
Tottenham	1,000,000
Tottenham	1,250,000
Tottenham	2,500,000
Tottenham	1,000,000
Tottenham	500,000
Tottenham	1,000,000
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Toulouse Natl. Wks.	2,400,000
Toulouse Natl. Wks.	6,200,000
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Tours	350,000
Trowbridge	250,000
Tunbridge Wells	1,000,000
Tunbridge Wells	1,000,000
Tunis	175,000
Tynemouth	1,100,000
Tynemouth	1,100,000
Ulm	400,000
Utrecht	1,000,000
Utrecht	1,000,000
Uxbridge	752,000
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Verviers	1,000,000
Vienna	3,500,000
Vienna	2,500,000
Walsall	750,000
Walsall	375,000
Waltham	400,000
Waltham	140,000
Wandsbek	125,000
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Wandsworth	4,230,000
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Ware	150,000
Ware	282,000
Warwick	125,000
Wasmuel	500,000
Watford	300,000
Watford	350,000
Watford	400,000
Wath	430,000
Weimar	100,000
Wellingborough	525,000
Wellingborough	525,000
Wellington, N.Z.	350,000
West Bromwich	550,000
Westgate	250,000
Weston-Mare	350,000
Weston-Mare	350,000
Weston-Mare	150,000
Weston-Mare	150,000
Wexford	100,000
Weymouth	400,000
Weymouth	300,000
Weymouth	658,000
Whitstable	423,000
Widnes	500,000
Wiesbaden	850,000
Winchester	225,000
Winchester	125,000
Winchester	410,000
Woking	400,000
Wolverhampton	1,500,000
Wolverhampton	1,000,000
Wolverhampton	250,000
Wolverhampton	400,000
Worthing	525,000
Yarmouth	500,000
Yarmouth	125,000
Yeovil	340,000
Zwolle	200,000
Zwolle	200,000
Zwolle	700,000

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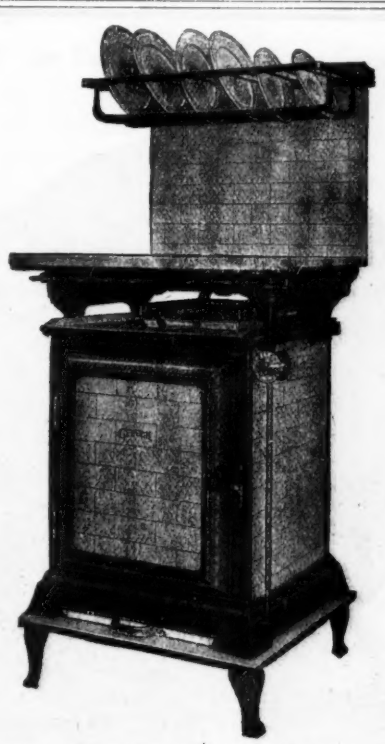

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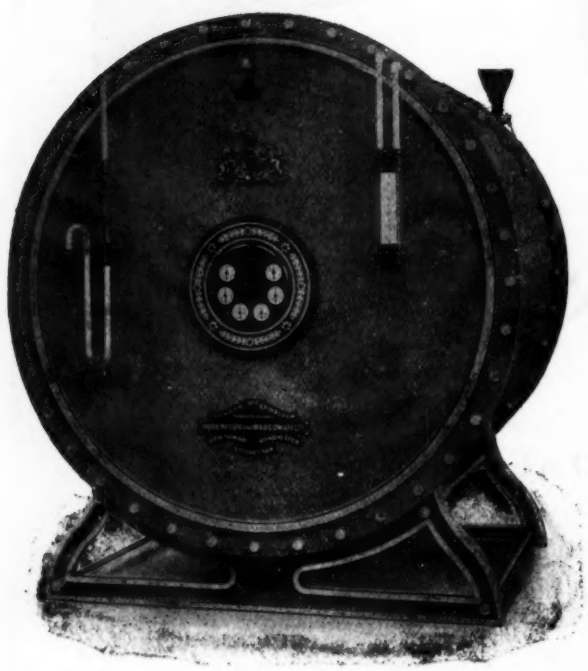

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